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FARMERS' BULLETINS

Nos. 701-725,

WITH CONTENTS AND INDEX.

PREPARED UNDER THE SUPERVISION OF

JOS. A. ARNOLD,

EDITOR AND CHIEF.



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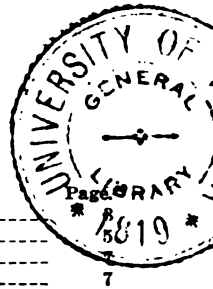
Contribution from the Bureau of Entomology, L. O. Howard, Chief.

THE BAGWORM, AN INJURIOUS SHADE-TREE INSECT.¹

By L. O. HOWARD and F. H. CHITTENDEN.

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GENERAL APPEARANCE AND NATURE OF ATTACK.

Shade trees, shrubs, and hedges, and in particular evergreens, are much subject to injury by a caterpillar which has a curious habit of crawling about on the infested trees in a baglike case, whence its common name of bagworm or basket worm.¹ In the shelter of these cases the insects undergo all their transformations, after which the bags remain attached to the plants for some time and are conspicuous objects on leafless trees and shrubs in late autumn and in winter. Like the tussock moth² and the fall webworm³ this species is preeminently a pest on trees and shrubs along streets and in parks and private grounds of cities and towns and even more than these is subject to fluctuation in numbers. It is, however, more limited in distribution than the two insects mentioned and not found as a rule

¹ *Thyridopteryx ephemeraeformis* Haworth; order Lepidoptera and family Psychidae.

² *Hemerocampa leucostigma* S. & A.

³ *Hyphantria cunea* Drw.

NOTE.—This bulletin is suitable for distribution in the southeastern portion of the United States.

north of southern New York and the central portions of Pennsylvania and Ohio. South of these points it is in certain years very troublesome and the subject of much complaint. Such a year was



FIG. 1.—Bagworm (*Thyridopteryx ephemeraeformis*). Natural size. (After Riley.)

1907, when the bagworm attracted greater attention than any other tree defoliator. Numerous complaints were received of injuries in the region mentioned, especially from the States of New Jersey, Pennsylvania, Maryland, Virginia, West Virginia, Ohio, Indiana, and Illinois. The natural enemies of this insect (see p. 7) were comparatively scarce, and there is a strong possibility of a recurrence of injuries in the years to come.

The general appearance of the bagworm is shown in figure 1, which illustrates the caterpillar when nearly full grown in its characteristic bag. When removed from its bag it looks as shown in figure 2, *a*, which represents the full-grown larva. At this period in its development it may attain a length of about three-fourths of an inch. The body is soft in texture and dull brownish or blackish, while the head and thoracic segments are horny and whitish, mottled with dark brown.

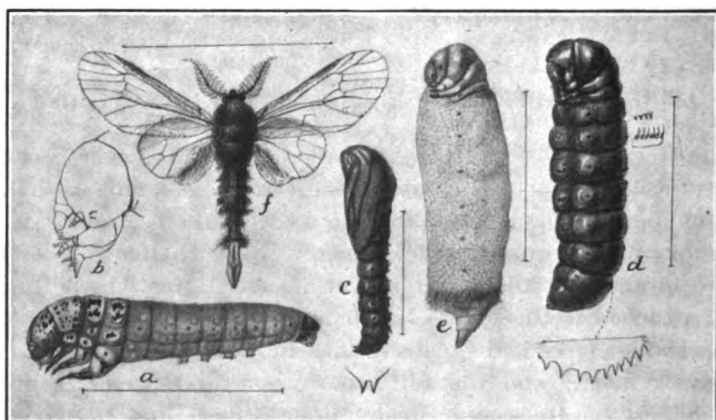


FIG. 2.—Bagworm (*Thyridopteryx ephemeraeformis*): *a*, Full-grown larva; *b*, head of same; *c*, male pupa; *d*, female pupa; *e*, adult female; *f*, adult male. All somewhat enlarged. (From Howard.) N. B.—The various stages are in reality a trifle longer than they are shown by the hair lines.

ORIGINAL HOME AND PRESENT DISTRIBUTION.

The bagworm is unquestionably native to North America. It abounds in the Southern States, except in the immediate Gulf region,

but is found farther to the north, and there are indications that it has gradually spread into this territory from more southern regions.

The map (fig. 3) which shows the region in which injury by the bagworm has been reported up to the year 1907 by black areas, and again during the two years 1913 and 1914 by shaded areas, as authenticated by the files of the Bureau of Entomology, may indicate that the species tends to spread toward the south and west. This apparent tendency, however, may be due merely to the planting of more trees in the more thickly populated towns and cities in such States as Oklahoma.

FOOD PLANTS.

The bagworm, although a very general feeder, displays a particular fondness for evergreens of all kinds, especially for arbor-

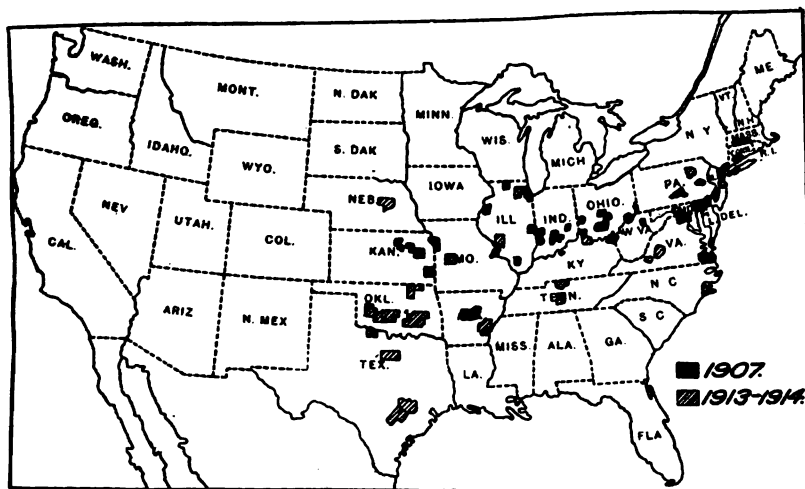


FIG. 3.—Map showing, by black areas, localities in which injury by the bagworm has been reported up to 1907 and, by shaded areas, those in which injury was reported in 1913 and 1914. (Original.)

vitæ (fig. 4); hence it seems probable that one or the other of these was its original or normal food plant. The species becomes exceedingly abundant every few years, and at such times it may be found on shade, orchard, and forest trees of nearly every kind. It is fond of willows and maples, particularly the silver maple and its varieties and the related boxelder; it is also fond of the poplars and mulberry, less so of the elms, and apparently still less so of the oaks. It feeds more or less freely, however, on most other trees and shrubs, and even on many low-growing semiwoody plants, such as elder, mallow (*Hibiscus*), and ragweed.¹ Thus in the absence of its choice food plants it is able to subsist on the foliage of almost any of the

¹ *Ambrosia trifida*.



FIG. 4.—Arborvitæ infested by bagworms. (Authors' illustration.)

plants of the character enumerated which may be available, but it does not seem to live on grasses and herbaceous plants generally.

HABITS AND LIFE HISTORY.

The bagworm overwinters in the egg stage within the old female bag, and for this reason hand picking in wintertime is an efficacious remedy. In the late spring the young hatch from the eggs, crawl out upon the twigs, make their way to the nearest leaf, and immediately begin to feed and to construct cases or bags for themselves. They spin a large quantity of silk, and attach to it for additional strength and protection bits of leaf or twig, evidently attempting to disguise the nature of the case as well as to strengthen it. The larva is remarkably soft-bodied, except for its head and strong thoracic plates, and it is necessary that the soft abdomen should have some protection.

The construction of the bag of an allied species of similar habits has been described as follows: The young larva cuts off with its jaws a small fragment of leaf which it places between its front legs, gradually forming a pile fastened loosely with silk. When the

pile becomes a transverse tangle about as long as the body, it is fastened at each end loosely to the surface upon which it rests; then the caterpillar, after placing itself at right angles, dives under the

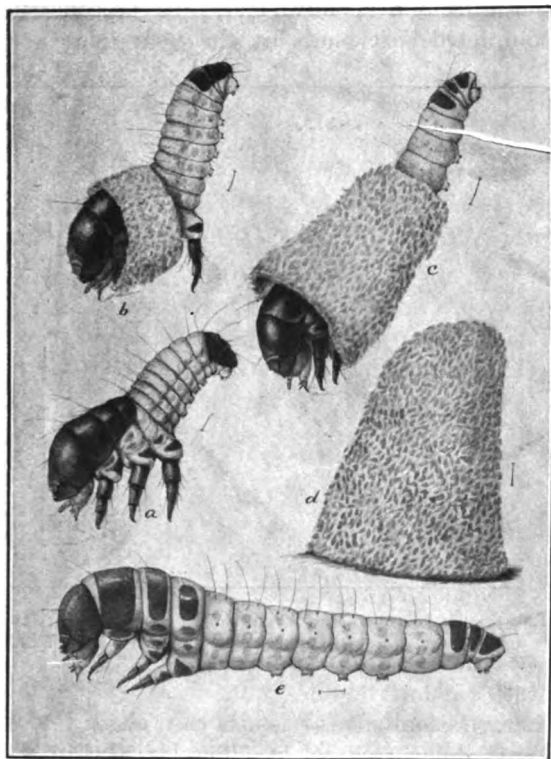


FIG. 5.—*a*, Newly hatched bagworm before making its case; *b*, same, just beginning case; *c*, same, with its case nearly completed; *d*, completed case, insect concealed within; *e*, larva after first molt. Highly magnified. (Authors' illustration.)

mass, turning a complete somersault, so that it lies on its back, bound down by the fillet. It then twists around and stands upon its feet, having its neck under a sort of yoke. It makes the yoke into a complete collar, adding bits to each end until the circle is complete. Then row after row of fragments is added until the case becomes a hollow cylinder. One end is then closed up, and the inside lined with a tough coating of silk, the case being then extended upright and fastened at one end. When it is fully completed, the larva crawls away with the case carried upright like a cap on the up-turned end of its body.

Figure 5, *a-c*, shows stages in the construction of the case and *d* a completed case made by the young larva, tightly appressed to the

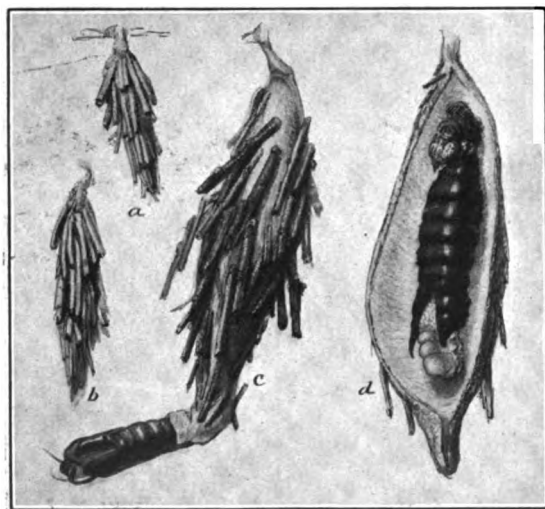


FIG. 6.—Bagworm at (*a, b, c*) successive stages of growth. *c*, Male bag; *d*, female bag. About natural size. (From Howard.)

flat surface, the larva being concealed within. Such bags may frequently be found on leaves, and are quite puzzling to the uninitiated until the larva pokes out its head and slowly walks off.

As the caterpillar grows, the case is constantly enlarged, bits of twigs and any other small objects being used to ornament the outside, and these objects will vary with the kind of tree upon which the caterpillar is feeding. While the

larva is small, it carries its case erect, but when it is larger the case hangs down (see fig. 1). The larval skin is cast four times, and during the molting the mouth of the bag is kept closed with silk. There is a small opening in the extremity of the bag through which excrement and cast skins are pushed. The male bags reach a length of about an inch, while those of the female are much larger.

Toward the end of August, about Washington, D. C., the larva completes its growth, attaches its bag firmly by a silken band to a twig, strengthens it inside with an additional layer of silk, and within this retreat, which now becomes its cocoon, transforms to pupa with its head downward.

The pupal period lasts about three weeks, and then the adult emerges. The male chrysalis works its way out of the lower opening,

and the winged moth issues through the cracking skin, leaving the chrysalis hanging from the bag, as shown at *c*, figure 6. The chrysalis of the female does not push its way at all out of the bag, but the skin cracks and the female gradually works her way partly out of the chrysalis skin, her head reaching the lower end of the bag (fig. 6, *d*). The males fly about seeking the bags of the females, and when one is found in which the head of the female is near the end, showing that she has emerged from her chrysalis skin, the male mates with her. The female then works her way back into the chrysalis skin, gradually filling it with eggs until more than half of it is filled, scattering in among the eggs some of the sparse hairs from her body. Having done this, she forces her shriveled body out of the opening, falls to the ground, and dies. The eggs remain in this way until the following



FIG. 7.—*Itoplectis inquisitor*: Female from side. Enlarged. (From Howard.)

spring when they hatch as previously described. There is thus only one generation annually.

NATURAL ENEMIES.

Although apparently well protected from the attacks of birds by its tough case, the bagworm is somewhat extensively parasitized by several forms of ichneumon¹ and chalcis flies,² most of them species which affect also similar tree-feeding caterpillars.

REMEDIES.

When the bagworm occurs upon deciduous trees it can be controlled by hand picking the bags in the winter, but when it affects evergreen trees it is practically impossible to apply this

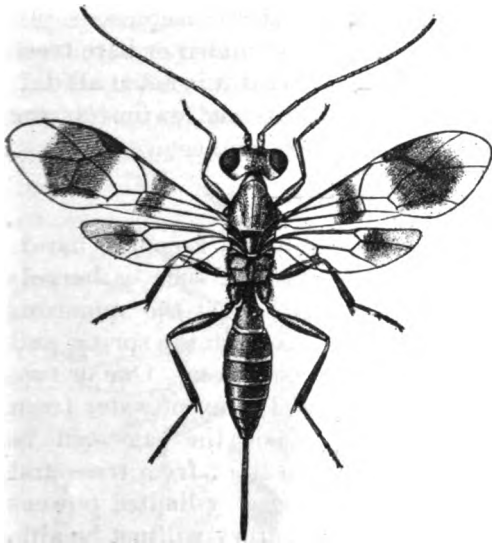


FIG. 8.—*Allocota thyridopterigis*. Much enlarged. (Authors' illustration.)

¹ (*Pimpla*) *Itoplectis inquisitor* Say (fig. 7), (*Pimpla*) *Itoplectis conquisitor* Say, and (*Hemiteles*) *Allocota thyridopterigis* Riley (fig. 8).

² *Spilochalcis mariae* Riley (fig. 9), *Chalcis ovata* Say (fig. 10), *Dibrachys boucheanus* Ratz. (fig. 11), and *Habrocytus thyridopterigis* Ashm. (fig. 12). Certain of these species are undoubtedly hyperparasitic; that is, parasites of the bagworm parasites.

remedy with profit unless the plants are badly defoliated. Therefore, for the treatment of evergreens, spraying is a necessity.

The methods of controlling shade-tree pests in cities and towns¹ are in part applicable to this species.

COLLECTING THE BAGS.

One of the most important remedies consists in gathering the bags with the contained insects by hand and either burning them or preserving them to liberate the useful parasites which have been previously mentioned. This work may be facilitated by the use of a 12-foot pole pruner or similar appliance. Where the trees are very tall it will be necessary to use a long ladder. For best results

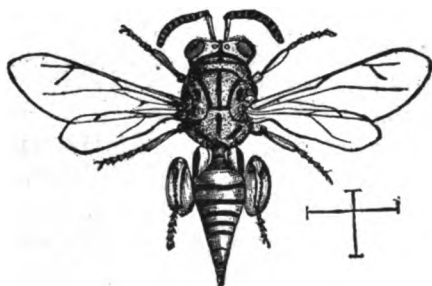


FIG 9.—*Spilochalcis mariae*. About four times enlarged. (After Riley.)

the cooperation of neighbors who are troubled with the same pest should be secured. Considerable immunity from future injury will result by care in the employment of this method. It is particularly useful where only a few trees are infested. The bags are such conspicuous objects on defoliated or bare trees in winter that it is not at all difficult to detect them, but in cases where comparatively few insects are present on evergreen trees they are not so easily seen.

in winter that it is not at all difficult to detect them, but in cases where comparatively few insects are present on evergreen trees they are not so easily seen.

ENCOURAGING THE PARASITES.

When many trees are infested it is advisable to keep the hand-picked bags for a considerable time in receptacles, such as barrels covered with netting, preferably wire netting, so that the numerous beneficial parasites of the pest will be able to issue in the spring and assist in the control of the bagworm the following year. One or two holes bored in the bottom of the barrel or box will prevent water from accumulating and drowning the insects. Where the bags can be placed in piles in an open space or inclosure distant from trees and free from disturbance, the young insects, having very limited powers of locomotion, will soon perish of starvation, as they will not be able to find the trees or shrubs after they hatch.

SPRAYING WITH ARSENICALS.

On evergreens, where the bags are more or less difficult to find, hand picking can not be advised. A striking instance of the futility

¹ Howard, L. O. Three Insect Enemies of Shade Trees. U. S. Dept. Agr., Farmers' Bul. No. 99, 32 p., 11 fig., 1899. This publication may be had free on application to the Department of Agriculture.

of this method under such circumstances was given by a former Government entomologist at a conference on the gipsy moth in 1891. He said that he once tried to protect a cedar tree not more than 6 feet high, upon his own grounds at Washington, by hand picking. He worked during two consecutive months picking off small bags from that tree, the progeny of not more than two females. Almost daily he went to the tree and found fresh specimens which he had overlooked the day before. For evergreen trees, therefore, an arsenical spray is the best remedy. Injury by the bagworm on large trees has been absolutely stopped by spraying with Paris green at the rate of 1 pound to 150 gallons of water, the trees being completely rid of larvæ. It is easier to reach the bagworms on evergreen than on large-leaved deciduous shade trees, such as maple and elm, but if carefully carried out, spraying will result in the destruction of the bagworms, so that the collection of the bags in winter will not be necessary. Arsenate of lead at the rate of 1 pound of the prepared paste form to from 25 to 50 gallons of water will be found even more effective than the

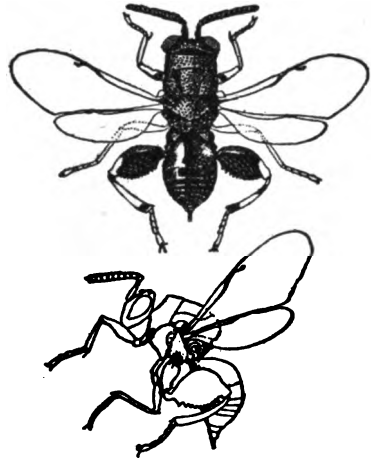


FIG. 10.—*Chalcis ovata*: Adult. Enlarged. (From Howard.)

Paris green, as its greater adhesiveness renders it less likely to be washed off by rains, which in some seasons frequently occur almost daily at the time when the larvæ are beginning to work.

Arsenate of lead is not at all likely

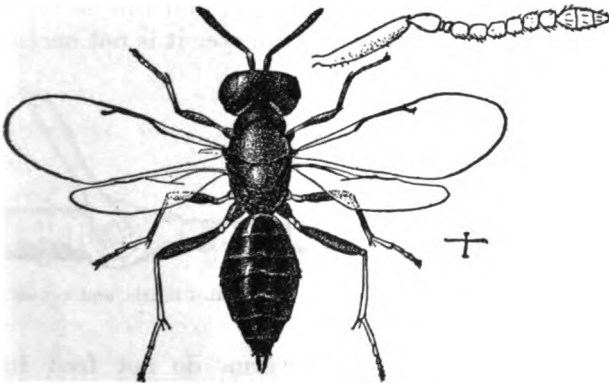


FIG. 11.—*Dibrachys doucheanus*: Adult female and antenna of male. Much enlarged. (From Howard.)

to produce scorching of the foliage of shade or ornamental trees or shrubs. Its natural adhesiveness is enhanced by the addition of about the same quantity by weight of resin-fishoil soap as of the arsenical used.

The question as to the best spraying apparatus to be used is an important one, the prime object being to destroy the insect without injuring the plant; the second, to avoid useless waste of the poison. Hand pumps and sprayers are unsatisfactory. One of the best types of orchard sprayer is desirable. This usually consists of a tank of about 100 gallons capacity equipped with a pump driven by a gasoline engine, mounted on a strong cart or wagon fitted with the

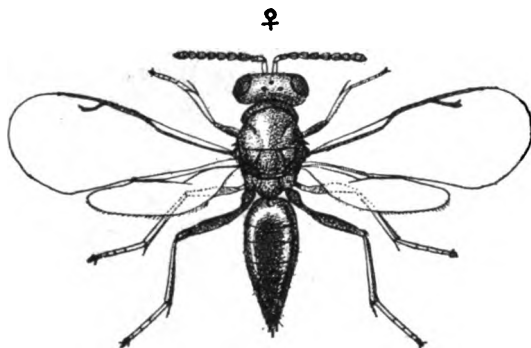


FIG. 12.—*Habrocytus thyridopterigis*. Greatly enlarged.
(From Howard)

proper length of hose and drawn by either one or two horses. Frequently one operator is enough, but two are better for most purposes, especially in the case of high trees.

In regard to nozzles, the older types, such as Vermorel and Bordeaux, may be used, but the new solid spray or

Worthley type (fig. 13) is preferable. In case tall shade trees in valuable parks or woodlands are to be treated—trees such as spruce, cypress, hemlock, and willow, as well as maples—high-power sprayers are preferable. The type which has given the most satisfactory results in the gipsy-moth work can develop sufficient power to carry a stream which breaks into a fine mist in the air, and this is very satisfactory in rapid treatment. With such a sprayer it is not necessary to climb trees or to use small lines of hose or turrets.

In the treatment of a great number of trees a greater strength, namely 2 or 3 pounds of arsenate of lead to 50 gallons of water or

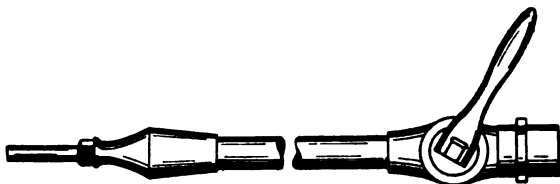


FIG. 13.—Solid spray or Worthley type of nozzle, and cut-off.
(Original.)

Bordeaux mixture, is desirable, as the bagworms do not feed in masses and the poison must be directed so as thoroughly to coat and remain on the foliage where it will be eaten with the leaves. The treatment should be thorough and the application made evenly in order to secure the best results. Recent inquiry has elicited the information that arsenate of lead is being used with the highest power sprayers even at the rate of 10 pounds to 50 gallons of water, which

we consider an unnecessary expenditure. Moreover, if two or three applications are made—and this is often desirable in case this or other insects continue to injure the trees—it is almost certain to affect injuriously or destroy some forms of tender leafage if made at this strength.

The best time to apply either of the arsenicals mentioned, as in the case of most insects, is at about the time when the eggs hatch or a day or two afterwards.

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- The Gipsy Moth in America. (Bureau of Entomology Bulletin 11, n. s.) Price, 5 cents.
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- Food Plants of the Gipsy Moth in America. (Department Bulletin 250.) Price, 10 cents.

UNITED STATES DEPARTMENT OF AGRICULTURE

FARMERS'
BULLETIN

WASHINGTON, D. C.

702

JANUARY 17, 1916

Contribution from the Bureau of Biological Survey, Henry W. Henshaw, Chief.

COTTONTAIL RABBITS IN RELATION TO TREES
AND FARM CROPS.By D. E. LANTZ, *Assistant Biologist.*

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INTRODUCTION.

Among the serious pests in orchards and tree plantations are the several native species of rabbits. These animals do considerable damage to garden truck and other farm crops also, especially on lands recently opened to cultivation. North American rabbits belong to two general classes easily distinguished by their size and habits.

The larger forms¹ include the arctic and varying hares, or snowshoe rabbits, and the jack rabbits, and are found throughout nearly all of Alaska and Canada and in all the States west of the Mississippi except Arkansas and Louisiana. East of the Mississippi they inhabit the northern parts of Minnesota, Wisconsin, and Michigan, most of New York and New England, and southward in the Appalachian Mountains, parts of Pennsylvania, Maryland, and Virginia.

The smaller forms,² generally called "cottontail rabbits," occur in every State, but are absent from the greater part of Maine, the

¹ Genus *Lepus*.² Genus *Sylvilagus*.

NOTE.—This bulletin discusses the distribution and habits of cottontail rabbits and methods of controlling their ravages on trees and cultivated crops by means of trapping, poisoning, and supplying safeguards. For general distribution.

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northern parts of New Hampshire, Vermont, New York, Michigan, Wisconsin, and Minnesota, and from the western parts of Washington and Oregon. In recent years they have extended their range northward in the New England States, New York, and portions of the West, and have invaded and occupied a considerable part of the Province of Ontario. In habits they differ materially from the larger rabbits. They live in copses and thickets more than in open fields. The young are born blind, naked, and helpless, while those of the larger rabbits have the eyes open, are partially furred, and active when born.

Rabbits of both genera, however, feed exclusively on vegetation, and are at times harmful to crops and especially to trees. Because of their size and great abundance in parts of their range, jack rabbits are by far the most destructive, but, except in a few places where they have been introduced, none are found east of the Mississippi. Epizootics (diseases which attack many animals at the same time) are an effectual natural check, and after such attack occurs, jack rabbits are usually so reduced in numbers that they are not troublesome again for several years.

Traps and other devices that are effective with cottontail rabbits do not always succeed with jack rabbits. The recommendations contained in this bulletin will, therefore, apply only to cottontail rabbits, but they may suggest methods that, with modifications, may be used against the larger forms.

HABITS OF COTTONTAIL RABBITS.

Cottontail rabbits (fig. 1) are so well known that little need be said of their habits. They breed several times each year during the warmer months, the litters averaging five or six young. The nest is usually placed in a hollow or depression of the ground, often in open fields or meadows. It is composed of dead grass and warmly lined with fur which the female pulls from her own body. The male rabbit takes no part in caring for the young, and the female weans them as soon as they are able to leave the nest. These animals breed so rapidly that in spite of many natural enemies, and of the fact that they are hunted for human food, they often become numerous enough to inflict serious losses on farmers and fruit growers in many parts of the United States (fig. 2).

Cottontail rabbits eat all sorts of herbage—leaves, stems, flowers, and seeds of herbaceous plants and grasses—and leaves, buds, bark, and fruits of woody plants or trees. They usually prefer the most succulent foods, as young shoots, tender garden vegetables, clover, alfalfa, and fallen ripe fruits; but they exhibit also a remarkable

delicacy of taste in their selection of certain varieties of cultivated plants and in their neglect of others of the same species. Prof. C. V. Piper reports that in Oregon rabbits ate Arabian alfalfa down to the ground, while they did little or no damage to other varieties grown in surrounding plats. Prof. C. A. Mooers, of the Tennessee Agricultural Experiment Station, reports similar observations in regard to their taste for soy beans, stating that they greatly relish the mammoth yellow variety and that it is practically the only one that suffers from their depredations. When favorite foods are absent rabbits resort to whatever is available. It is during summer droughts



FIG. 1.—Cottontail rabbit in its "form."

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or when deep snows cut off ordinary supplies that the animals attack the bark of growing trees or shrubs.

PROTECTION OF RABBITS.

Cottontail rabbits are valuable for food and afford excellent sport for gunners. In many States, especially east of the Mississippi River, they are protected as game. In fruit-growing and truck-farming districts farmers regard them with disfavor, and there is considerable rivalry between sportsmen and farmers to have their opposing views reflected in game laws. The interests of the two classes do not seriously differ, however, for when rabbits are closely

hunted losses from their depredations are usually reduced to a minimum. Still there is danger that in years favorable for their increase the animals may inflict serious injury to trees during severe winters.

Rabbits are protected (1915) by close seasons in States and Provinces as shown in Table I. Twenty-eight States, Alaska, and the Canadian Provinces not mentioned in the table do not protect rabbits of any kind. In the District of Columbia all shooting is pro-

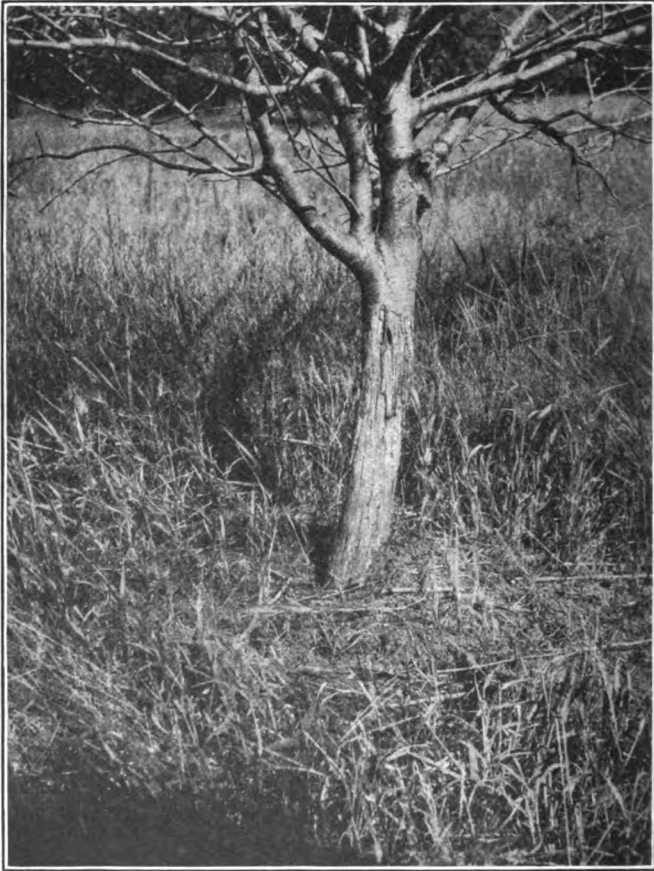


FIG. 2.—Apple tree killed by rabbits.

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hibited except on certain river marshes. In Kentucky rabbits may be taken with dog, trap, or snare at any time, and the close season for shooting is evidently solely for the purpose of keeping gunners out of fields and woods during the two months immediately preceding the open season for quails. In Wisconsin 46 counties, mostly in the southern half of the State, have no close season for rabbits. In California only cottontails, or bush rabbits, are protected.

TABLE I.—Lengths of open season for rabbits or hares.

State or Province.	Begin- ning of open season.	Begin- ning of close season.	Length of open season.
			<i>Months.</i>
Maine.....	Oct. 1	Apr. 1	6
New Hampshire.....	do.	Mar. 1	5
Vermont.....	Sept. 15	do.	5½
Massachusetts.....	Oct. 12	do.	4½
Rhode Island.....	Nov. 1	Jan. 1	2
Connecticut.....	Oct. 8	do.	2½
New York.....	Oct. 1	Feb. 1	4
Long Island.....	Nov. 1	Jan. 1	2
New Jersey.....	Nov. 10	Dec. 16	1½
Pennsylvania.....	Nov. 1	Dec. 1	1
Delaware.....	Nov. 15	Jan. 1	1½
Maryland.....	Nov. 10	Dec. 25	1½
District of Columbia.....	Nov. 1	Feb. 1	3
Virginia.....	do.	do.	3
Kentucky.....	Nov. 15	Sept. 15	10
Ohio.....	do.	Dec. 5	3
Indiana.....	Apr. 1	Jan. 10	9½
Illinois.....	Aug. 31	Feb. 1	5½
Michigan.....	Oct. 1	Mar. 2	5½
Wisconsin:			
6 counties.....	Sept. 10	Feb. 1	4½
13 counties.....	Oct. 10	do.	3½
6 counties.....	Nov. 1	Jan. 1	2
Colorado.....	Oct. 1	Mar. 1	5
California.....	July 31	Feb. 1	6½
British Columbia.....	Sept. 1	Jan. 1	4
Ontario.....	Oct. 1	Dec. 16	2½
Quebec:			
Zone 1.....	Oct. 15	Feb. 1	3½
Zone 2.....	do.	Mar. 1	4½
Newfoundland.....	Sept. 20	Jan. 1	3½
Prince Edward Island.....	Nov. 1	Feb. 1	3
Nova Scotia.....	Oct. 1	Mar. 1	5

In about half the States that have a close season for rabbits the laws permit farmers and fruit growers to destroy the animals to protect crops or trees. Such provision might well be incorporated in game laws of all States. For lack of it farmers have sometimes suffered severe losses, and not a few have been compelled to pay fines for trying to protect their property from rabbits. In States that protect rabbits it is well for the farmer to be acquainted with the game laws and in case of doubt to have a clear understanding with local and State game wardens before undertaking to destroy rabbits.

MEANS OF REPRESSING RABBITS.

NATURAL ENEMIES.

Among the agencies that help to keep down the numbers of rabbits few are more effective than carnivorous birds and mammals. These include large hawks and owls, eagles, coyotes, wildcats, foxes, minks, weasels, dogs, and cats. Eagles, the larger species of hawks, and all the large and medium-sized owls make rabbits a great part of their food. From the standpoint of the farmer and fruit grower these birds and certain carnivorous mammals are far more beneficial than harmful. On the other hand, poultry growers and sportsmen regard them as enemies to be destroyed whenever possible. In the absence

of such natural enemies, rabbits, as well as rats and mice, often become a menace to valuable crops. Indiscriminate slaughter of carnivorous birds and mammals should be suppressed whenever rodent pests are to be controlled.

HUNTING.

Hunting has been the most important factor in keeping down the numbers of rabbits in America. In some parts of the country the animals have been so reduced in numbers by shooting that sportsmen have invoked legislation to prevent their extermination. Shooting is undoubtedly the best method for hunting this animal. Ferreting is often impracticable, since our native rabbits do not habitually burrow; besides, the use of ferrets is forbidden by law in many States that protect the rabbit. Coursing with greyhounds is popular in the West, where the swifter jack rabbits are abundant. Cottontails are often chased with foxhounds, but the beagle is rapidly taking precedence as a favorite for hunting these animals, the gun being used to secure the game.

Where the country is sufficiently open for the purpose, the organized hunt, in which everyone who owns a gun is supposed to take part, is a good means of reducing the number of rabbits. These organized hunts are popular in the West, where they are also varied, in the case of jack rabbits, by what is known as the "rabbit drive." A large territory is surrounded by men and the animals are driven into a corral built of wire netting. While a few cottontails are sometimes included in the catch, these usually find refuge in open burrows or under cover of rocks or brush, so that this method is hardly applicable to them.

TRAPPING.

Rabbits are easily trapped or snared, and while these methods of taking them are slow, they are always feasible when cottontails infest woodlot, orchard, nursery, field, or garden. Many are caught in old-fashioned box traps set with a figure-4 trigger with cord attached to hold up the box lid.

An improvement on this familiar trap, widely used in the Middle West, and often called the Wellhouse¹ trap, is a box 21 inches long and about 6 inches high and 4 inches wide (inside measurements) made of 6-inch fence boards, preferably old ones. The box is closed at the rear and has a wire door in front which swings inward from the top, a cleat at the bottom preventing its opening outward. The trap is set and the wire door kept open by a wire trigger-rod held in place by two staples in the top of the box. The trigger-rod is bent downward into a loop or figure 8 near the rear of the trap. As the

¹ After the late Mr. Fred Wellhouse, of Topeka, Kans.

rabbit enters the trap and crowds into the back part it presses against the loop, moves the trigger-rod backward and is imprisoned as the wire door is released and falls. Bait may be used but is unnecessary, since cottontails frequently take refuge in dark places from enemies or inclement weather.

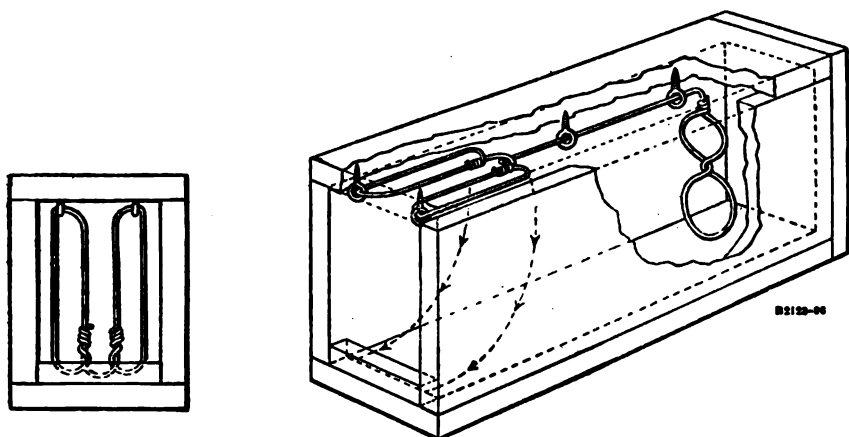


FIG. 3.—Details of a Wellhouse rabbit trap.

The materials needed for making a Wellhouse trap are: Four boards 1 by 6, 21 inches long, for the sides; a piece 1 by 6, 8 inches long, for the back; a small cleat for the door stop; $28\frac{1}{2}$ inches of wire for the door; 22 inches of wire for the trigger; 4 small staples for hanging the door and trigger; and nails (fig. 3).

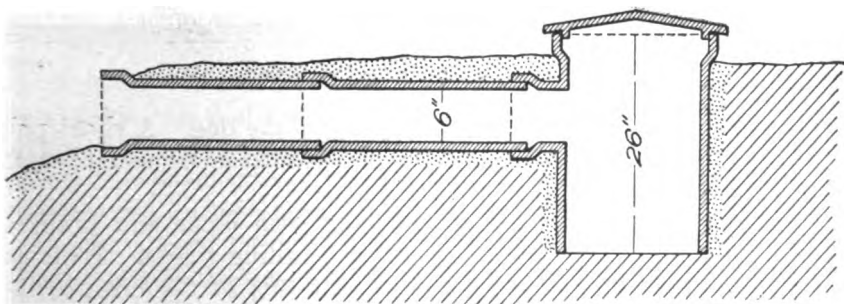


FIG. 4.—Cross section of a Walmsley tile trap for rabbits.

Mr. J. M. Walmsley recently sent to the department photographs and a description of a permanent rabbit trap made of sewer tile and used on his and other farms in Kansas (fig. 4). A 12 by 6 inch "tee" is set with the long end downward and buried so that the 6-inch opening is below the surface of the ground. Two lengths of 6-inch sewer pipe are then connected horizontally with the opening. Soil is

placed over the joints to exclude light. The upright tile should be fitted with a tight removable cover—Mr. Walmsley uses old harrow disks for the purpose. The projecting end of the small tile is surrounded with rocks, brush, or wood, so as to make the hole look inviting to rabbits (fig. 5), and that they may appropriate the den as a place of concealment and shelter. A number of these traps in various places, and especially in the vicinity of the orchard, have kept Mr. Walmsley's farm comparatively free of rabbits. Rabbits occupy these tile traps, go in or out at will, and may be captured when desired. Whenever Mr. Walmsley visits his traps he is accompanied by a trained dog that locates the trapped animals. The cover is lifted from the upright tile and the rabbit captured by hand; if it

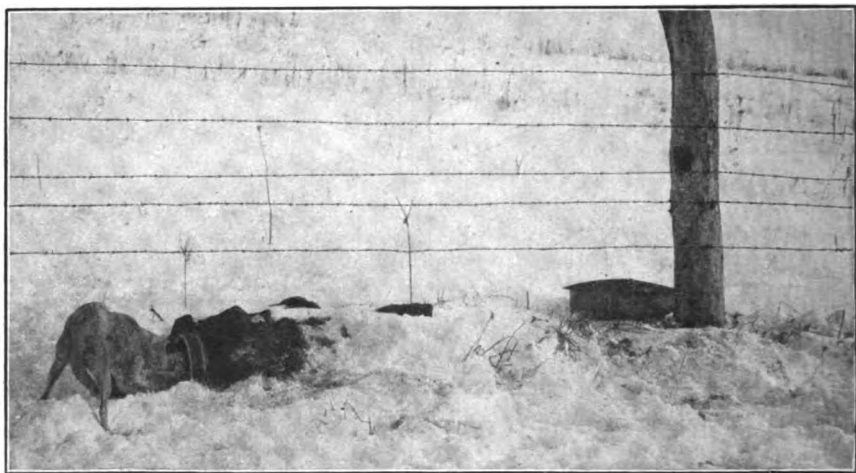


FIG. 5.—A Walmsley tile trap in use.

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bolts from the side opening it is caught by the dog. A short pole fitted with a 5-inch wooden disk may be inserted in the side opening to prevent escape.

These traps are especially suitable for open lands and prairies, where rabbits can not find many natural hiding places. Built on waste land, they may become a permanent part of the farm equipment and will cost nothing for repairs from year to year. Their first cost may be greatly reduced by use of second-grade or even broken tiles. If one wishes to poison rabbits, the baits may be placed inside these traps and domestic animals or birds will not be endangered. The Walmsley trap also furnishes an excellent means of obtaining rabbits for the table or even for market without damaging them by shooting.

POISONING.

Poison for killing rabbits has been used in the West with considerable success. Only in exceptional cases, however, is its use advisable in States that protect rabbits. The most favorable season for using poison is in winter or after a long drought in summer has made green food scarce. In some localities summer poisoning is interfered with by crickets or grasshoppers consuming the bait.

The following method is adapted for general use: Insert crystals of strychnine or powdered strychnine in pieces of apple or melon rind and place these baits at intervals along rabbit runs or paths. **Take care to put the poisoned baits where children and domestic animals can not get them.** Where no well-defined runs are visible in orchards, artificial ones may be made with a narrow drag or scraper. Along such runs or the dead furrows of plowed fields rabbits habitually travel. Baits may be placed on the ground or elevated on short sticks along the path, and should be looked after with care. **Any baits left after poisoning operations are finished should be destroyed.**

For poisoning rabbits in winter or during droughts the following formula is recommended: Good oats, 12 quarts; powdered strychnine, 1 ounce; laundry starch, 1 tablespoonful; soda (bicarbonate), 1 ounce; saccharine, $\frac{1}{8}$ ounce; water, 1 quart. Mix the starch with $\frac{1}{2}$ pint of cold water. Pour this into $1\frac{1}{2}$ pints of boiling water and continue the boiling for a minute or two until the starch is clear. Mix the dry strychnine and soda in a small pan and sift it over the hot starch, stirring thoroughly to form a smooth paste. Add the saccharine and stir again. Pour the mixture over the oats in a metal tub, mixing until all the grain is wet. Allow the oats to dry before distributing. Not over a tablespoonful of the grain should be put in a single bait and this should be scattered considerably. A little alfalfa hay will help attract rabbits to the poisoned grain. This poison is recommended for use when snow covers the ground. It is effective against both cottontails and large rabbits.

Partly ripened heads of barley or wheat soaked in a solution of strychnine and saccharine or coated with the starch-strychnine solution just described have also proved effective baits for rabbits, but **great care must be exercised in using them, as they are likely to be eaten by live stock.**

Cottontail rabbits may be poisoned in winter by baiting them with twigs cut from apple trees and dipped in or thinly coated with the starch-strychnine poison. These twigs are scattered along rabbit trails and are effective against both meadow mice and rabbits. They are less dangerous to domestic animals than grain baits.

BACTERIAL DISEASES.

The fact that when rabbits become excessively abundant in any locality epizootic diseases often destroy them in large numbers has led many people to expect that a micro-organism would be found which would afford a ready means of rabbit control. The Biological Survey receives many applications for such bacterial preparations. In reply to all of them it has been necessary to state that thus far all attempts to spread contagious disease artificially among wild rabbits have failed to give practical results.

PROTECTION OF CROPS FROM RABBITS.

Complete extermination of rabbits in any part of the United States is not desirable, even if possible. They should be reduced in numbers only sufficiently to secure comparative safety to crops, and before active wholesale destruction of the animals is attempted the possibility of crop protection by other means should be carefully considered. In many cases one of these means would probably be the more economical method.

RABBIT-PROOF FENCES.

When rabbits are abundant and the area to be protected is not too great, a rabbit-proof fence may profitably be used. Woven-wire netting is recommended for this purpose. This material is in general use, not only against the rabbit pests of Australia and Europe, but in our own country against both large and small rabbits. As our species burrow less than the European rabbit the requirements for rabbit proofing a fence here are not so great. Even the cottontails, when driven by hunger, will dig under a fence, but this may be prevented either by use of wire with close barbs in contact with the ground or by plowing a furrow against the lower edge. A netting of galvanized wire with $1\frac{1}{2}$ -inch mesh and $2\frac{1}{2}$ to 3 feet high is a sufficient barrier against cottontails. Where snow is infrequent market gardeners and nurserymen use a 2-foot fence, but in the North they prefer to use a netting $3\frac{1}{2}$ feet wide, and to turn from 4 to 6 inches of the lower edge flat and cover it with soil. Netting made of No. 20 wire costs from 25 to 35 cents a rod. Heavier netting slightly increases the cost, but adds to the durability of the fence. Where lumber is cheap, a picket fence or one made of laths and wire is practicable. When deep snows fall and drifts form, fences offer no protection to crops against rabbits.

TREE PROTECTION.

WASHES.

Many devices for protecting trees from rabbits have been recommended, the majority of which are paints, smears, or washes supposed to be distasteful to the animals. Many are not sufficiently

permanent to afford protection for an entire winter, and most of those that are lasting are injurious to trees. Coal tar, pine tar, tarred paper, and oils, under certain conditions, are dangerous to young trees. Carbolic acid and other volatile substances afford only temporary protection, and must be renewed too often to warrant their use. Bitter substances, like commercial aloes and quassia, are useless against rabbits.

The most promising simple washes for protecting large trees from rabbits are those containing lime mixed with sulphur or copperas in various combinations. Lime alone is not sufficiently permanent, especially where much rain falls. When mixed with sufficient copperas it has a deep green color and sticks much better. The lime-sulphur wash commonly used to destroy San Jose scale in winter has often proved successful as a rabbit repellent, but its lack of adhesive qualities often makes it fail. The defects may be partly corrected by mixing salt, soap, or a cheap glue with the lime and sulphur while the wash is still hot.

A poisoned wash of starch and glycerin, tried during the winter of 1913-14 in Idaho by a field agent of the Biological Survey, gave excellent results in protecting young orchards from jack rabbits, and would probably be equally effective where cottontails are concerned. The wash is prepared as follows:

Dissolve 1 ounce of strychnine (sulphate) in 3 quarts of boiling water. Dissolve $\frac{1}{2}$ pound of laundry starch in 1 pint of cold water. Pour the starch into the vessel containing the strychnine and boil the mixture a short time until it is clear, adding 6 ounces of glycerin and stirring thoroughly. When it is cool enough apply with a paint brush to the tree trunks.

The glycerin and starch adhere well and form a thin coating to the bark. Rabbits attacking the trees will be quickly killed. In the Idaho experiments none of the trees were damaged badly enough to affect their growth and all the rabbits in the orchards were destroyed. The method is well worth trying; but care should be taken not to endanger domestic animals.

MECHANICAL CONTRIVANCES.

Among the best mechanical contrivances for protecting trees from rabbits are cylinders of woven wire netting. Poultry netting of 1-inch mesh, made of No. 20 galvanized wire, will answer every requirement. Rolls 18 inches wide are used for cottontails, and the material is cut into 1-foot lengths. One of the sections is rolled into cylindrical shape about the trunk of each tree and fastened at several places by bending and twisting the projecting ends of wire. No other fastening is needed, but stakes or spreaders may be used to prevent rabbits from pressing the wire against the bark and doing

injury through the meshes. These guards should be left on the trunks, and will last as long as the trees require protection. The cost of material is less than 2 cents for each tree. These protectors may vary in size to suit the requirements of any particular locality or kind of tree. They may be adapted to protection from the larger rabbits by using wider rolls and to protection from both meadow mice and rabbits by using wire of finer mesh and by pressing the lower edges into the ground.

Veneer and other forms of wooden protectors are popular, and have several advantages when used for cottontail rabbits. When left permanently upon the trees, however, they furnish retreats for insect pests. For this reason they should be removed each spring. While the labor of removing and replacing them is considerable, they have the advantage when pressed well into the soil of protecting from both mice and rabbits. They cost from 60 cents a hundred upward, and are much superior to building paper or newspaper wrappings. The writer has known instances where rabbits tore wrappings of building paper from apple trees and in a single night injured hundreds. "Gunny-sack" and other cloth wrappings well tied on are effective protectors. Cornstalks furnish a cheap material for orchard protection when cut into lengths of 18 to 20 inches, split, and tied with the flat side against the tree, so as fully to cover the trunk. However, they last but one season and putting them in place involves much labor.

OTHER MEANS.

Few of these methods for the protection of individual trees in orchards or elsewhere are applicable to young woodlands or forest plantations where trees grow close together. In these cases the only remedy is the destruction of the animals or their exclusion by wire nettings.

Clean cultivation, generally, possesses advantages in preventing rabbit depredations, since it reduces the number of places of refuge for the animals; but rabbits go long distances in search of food, especially in winter, and clean cultivation can not be applied on the western plains, where dense windbreaks are essential to successful orcharding.

Feeding rabbits in winter to prevent their attacks on orchards has been practiced successfully, on the theory that it is cheaper to feed than to fight them. One plan is to leave the winter prunings of apple trees scattered about the orchard. Another is to furnish corn, cabbage, or turnips in sufficient quantity to provide food for the rabbits during cold weather. These methods have considerable merit, particularly the first, which seems to give satisfactory results when both mice and rabbits are present.

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UNITED STATES DEPARTMENT OF AGRICULTURE



FARMERS BULLETIN



WASHINGTON, D. C.

703

JANUARY 14, 1916

Contribution from the Office of Markets and Rural Organization, Charles J. Brand, Chief.

SUGGESTIONS FOR PARCEL POST MARKETING.¹

By LEWIS B. FLOHR, *Investigator in Marketing by Parcel Post*, and C. T. MORE, *Investigator in Grades and Standards*.

INTRODUCTION.

This bulletin contains information and suggestions for persons desiring to sell or buy produce by parcel post. A great deal of marketing has been and is now being done by this method. Many persons, however, are only partially informed or perhaps entirely unaware of the requirements necessary to market farm produce successfully in this manner. An extensive campaign of education is necessary in order that both producers and consumers may realize its possibilities as well as its limitations. The increased cost of living has caused many persons to look to securing produce by parcel post as a means of relief, and some have been disappointed because of unsatisfactory results arising from various causes. Physically the transportation of practically all kinds of produce is a possibility; economically it is frequently not justifiable.

A thorough study of the possibility of marketing farm products by parcel post is being conducted by the Department of Agriculture with the intention of publishing the results in a series of bulletins, each dealing with a specific phase of the question. The first of these publications, "Shipping Eggs by Parcel Post," was issued as Farmers' Bulletin 594. The present bulletin contains general information which has been accumulated in the course of these investigations and which should be of use to those producers and consumers who are interested in the more general phases of the subject.

¹ This bulletin is written for producers and consumers in all parts of the country who are interested in marketing by parcel post.

CONTACT.

One of the most important requirements is the bringing of the producer and the consumer into business contact. This may be attained (1) by personal acquaintance; (2) through the acquaintance of a third person; (3) by advertising in an appropriately selected paper; (4) by personal canvass; and (5) through the post office in the city or town in which a customer is sought.

Once a satisfactory parcel post business is established with or through an acquaintance, other customers are likely to be secured through the first one. Advertising frequently may bring the producer into touch with a prospective purchaser. Some papers run a special parcel post advertising department or section and a brief but well-worded advertisement often will bring results.

Another method is for the producer to make a personal canvass in a residence section of the town or city selected. Good, representative samples of the produce available at the time doubtless will help to secure the first sale.

The postmasters in 35 cities of the country, under the direction of the Post Office Department, have instituted campaigns intended to foster parcel post marketing. The names and addresses of producers, together with the produce offered, are listed for distribution to the patrons of the offices; and some of these postmasters issue for distribution to producers, lists of consumers who wish to buy.

The cities are as follows:

Athens, Ga.	Lincoln, Nebr.
Atlanta, Ga.	Los Angeles, Cal.
Austin, Tex.	Louisville, Ky.
Baltimore, Md.	Lynn, Mass.
Birmingham, Ala.	Minneapolis, Minn.
Boston, Mass.	Nashville, Tenn.
Brooklyn, N. Y.	New Orleans, La.
Chicago, Ill.	Philadelphia, Pa.
Cincinnati, Ohio.	Portland, Oreg.
Cleveland, Ohio.	Providence, R. I.
Dallas, Tex.	Richmond, Va.
Denver, Colo.	Rock Island, Ill.
Detroit, Mich.	San Francisco, Cal.
Galveston, Tex.	Seattle, Wash.
Hartford, Conn.	St. Paul, Minn.
Indianapolis, Ind.	St. Louis, Mo.
La Crosse, Wis.	Washington, D. C.
Lawrence, Mass.	

POSTAL REQUIREMENTS.

Persons desiring to market by parcel post should acquaint themselves with the time at which mails are dispatched from their post offices, so that they may regulate the preparation and mailing of

parcels accordingly. On rural delivery routes this suggestion can not always be followed. In some cases certain patrons can intercept the carrier, on his return trip, at no great distance from their homes, while others may find it convenient to take the weekly shipment direct to the post office themselves when going to town on their weekly shopping trip. Where it is possible, perishable shipments should be made so as to reach destination for delivery during ordinary delivery hours. Postmasters will give information as to the postal requirements for mailing the various kinds of produce.

Parcels containing perishable articles must be marked "Perishable"; eggs must be marked "Eggs"; any parcel containing glass must be marked "Fragile." Articles likely to spoil within the time reasonably required for transportation and delivery are not accepted for mailing.

If desired, a receipt can be secured from any postmaster, acknowledging the mailing of a parcel, on the payment of 1 cent. For 3 cents a parcel may be insured against loss if not valued at over \$5.

PARCEL POST ZONES.

The United States is divided into "units," each one of which is numbered, as illustrated in figure 1. The center of each unit constitutes the center of the zones for all post offices within that unit. The first zone consists of any given unit together with all the adjoining units, even though they but touch at the corner. The second zone embraces all those units within a radius of 150 miles from the center of any given unit. The whole of any unit, any part of which is touched by this 150-mile boundary line, is considered entirely within that zone.

There is a separate zone map or chart for each unit. Figure 1 shows a section of the map for the unit in which Washington is located. The second circle shows the nominal boundary of zone 2; but owing to the fact that all units which are touched by this boundary line fall entirely within the second zone, the units which are bounded by the heavy line (outside the second circle) are entirely within zone 2. This principle applies to all other zones—that is, any unit which is touched at any point by the boundary of a given zone lies wholly within that zone and is so considered for the purposes of the parcel post service.

Particular description is here given of the first and second zones because the great bulk of the shipping of farm products by parcel post is likely to be done within these zones. The rate can be ascertained readily from the accompanying tables.

Table 1 gives the local parcel post rates applying to parcels which are not sent beyond the territory of the mailing office.

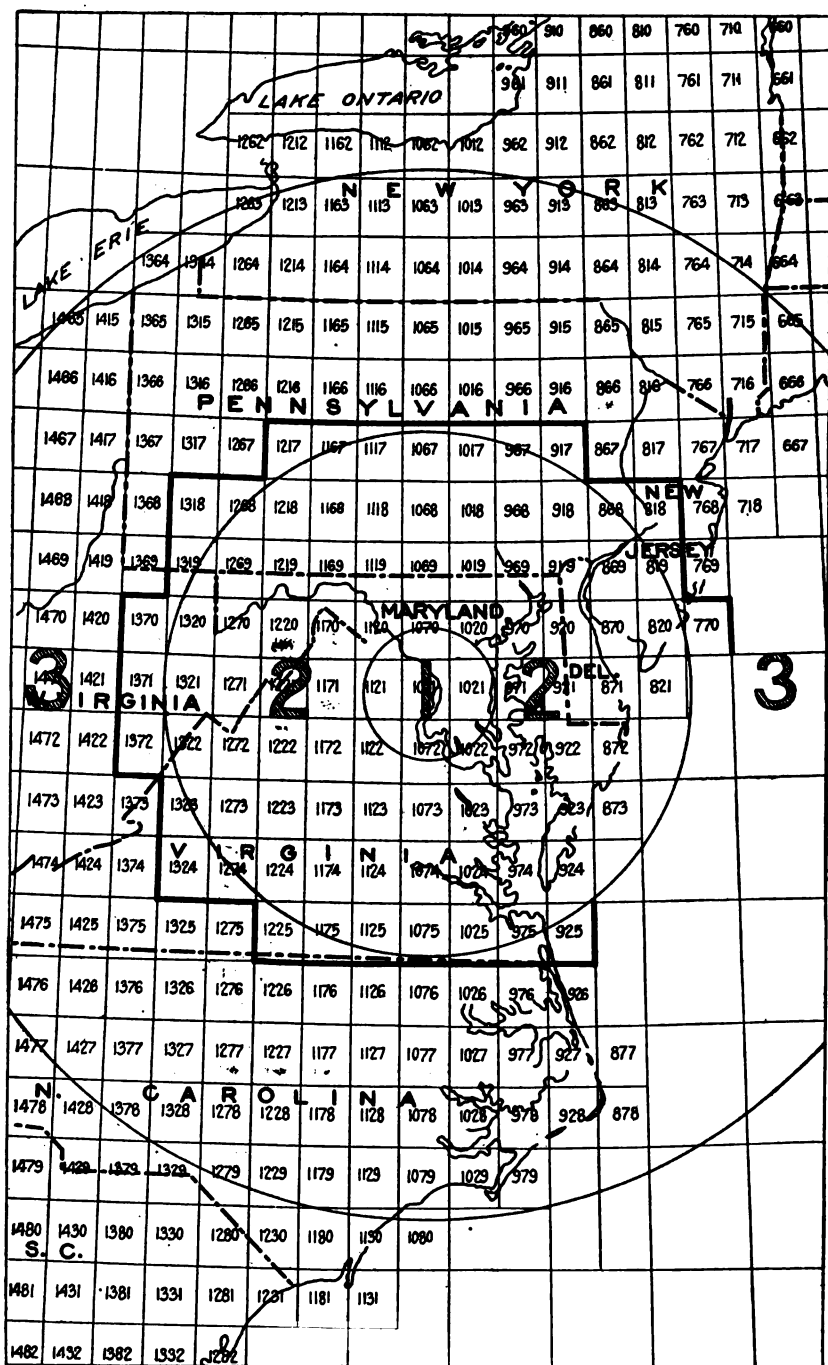


FIG. 1.—This illustration shows a section of parcel post zone map for Washington, D. C., and all other post offices in unit 1071.

TABLE 1.—*Local parcel post rates.*

Pounds.	Postage.	Pounds.	Postage.	Pounds.	Postage.	Pounds.	Postage.	Pounds.	Postage.
	<i>Cents.</i>		<i>Cents.</i>		<i>Cents.</i>		<i>Cents.</i>		<i>Cents.</i>
1	5	11	10	21	15	31	20	41	25
2	6	12	11	22	16	32	21	42	26
3	6	13	11	23	16	33	21	43	26
4	7	14	12	24	17	34	22	44	27
5	7	15	12	25	17	35	22	45	27
6	8	16	13	26	18	36	23	46	28
7	8	17	13	27	18	37	23	47	28
8	9	18	14	28	19	38	24	48	29
9	9	19	14	29	19	39	24	49	29
10	10	20	15	30	20	40	25	50	30

Fifty pounds is the weight limit for local delivery. The rates are 5 cents for the first pound and 1 cent additional for each additional 2 pounds or fraction thereof.

TABLE 2.—*First and second zone parcel post rates.*

Pounds.	Postage.	Pounds.	Postage.	Pounds.	Postage.	Pounds.	Postage.	Pounds.	Postage.
	<i>Cents.</i>		<i>Cents.</i>		<i>Cents.</i>		<i>Cents.</i>		<i>Cents.</i>
1	5	11	15	21	25	31	35	41	45
2	6	12	16	22	26	32	36	42	46
3	7	13	17	23	27	33	37	43	47
4	8	14	18	24	28	34	38	44	48
5	9	15	19	25	29	35	39	45	49
6	10	16	20	26	30	36	40	46	50
7	11	17	21	27	31	37	41	47	51
8	12	18	22	28	32	38	42	48	52
9	13	19	23	29	33	39	43	49	53
10	14	20	24	30	34	40	44	50	54

The weight limit within the first and second zones is 50 pounds. The rates apply to all points within the first and second zones, there being no difference in rates between these two zones. A simple rule to determine the postage on any parcel not going beyond the second zone is to add 4 to the number of pounds, and the resulting number is the postage required in cents. Example: A parcel weighs 13 pounds and 11 ounces; this will require postage on 14 pounds (as any fraction of a pound is considered a full pound); 14 plus 4 equals 18 cents postage.

An exception to these rates of postage is made when the office to which the parcel is addressed, though geographically within the second zone, is 300 or more miles distant by the shortest regular mail route. The rates are then 6 cents for the first pound and 2 cents additional for each additional pound.

The weight limit for the third, fourth, fifth, sixth, seventh, and eighth zones is 20 pounds. Further information as to rates, zones, and similar questions may be obtained at any post office.

MEASUREMENT LIMITS FOR PARCEL POST MAIL MATTER.

In addition to the weight limits shown in connection with the postage tables given, there is a measurement limit, which is the same for all zones. This limit is that the girth (measurement around) and the length added must not exceed 84 inches. For example, a parcel 12 inches square (48 inches around) and 36 inches long would be just up to the limit; as would also a parcel 14 inches square (56 inches around) and 28 inches long. A parcel cubical in shape and 16 inches in each dimension would measure 64 inches around, and to this would be added 16 inches for length, making 80 inches, or 4 inches less than the limit.



FIG. 2.—A parcel-post market basket of assorted vegetables, covered (cover sewed on). Weight 26 pounds, postage 30 cents within first and second zones.

The foregoing postal information was that in effect December 20, 1915.

CONTAINERS.

One important requirement for parcel post shipping and marketing is a proper and satisfactory container. Sometimes the consumer can secure containers more readily and economically than the producer. Those with handles are much less likely to be damaged in transit in the mails than those which are not thus supplied and which are likely to be tossed or thrown or handled by the string or twine used in tying them. A bamboo basket, such as is shown in figures 2, 3, and 4, serves the purpose very well and may be used a long time.

Ordinary splint baskets made of strips of veneer may also be used, and if they can be secured at a price sufficiently cheap a new one for each shipment is more economical than having them returned, unless they are sent back in lots of 10 or more under one cover. This, of course, necessitates using them without a wooden handle, in which case a heavy twine should be used for a handle. This twine can be untied and the baskets nested, or placed in one another, for return shipment. If a basket with a wooden handle is used, care should be taken to see that it is securely nailed, not only at the rim of the basket but farther down toward the bottom, so as to prevent undue leverage which may break loose the nailing.



FIG. 3.—Same basket as in figure 2, opened.

Corrugated pasteboard cartons frequently may be found useful and desirable for this service. They are made in a great variety of sizes, dimensions, and patterns, and when empty are shipped "knocked down" flat, as may be seen in figure 5.

PACKING PRODUCE FOR SHIPMENT.

Few persons know how to prepare and pack fruit and produce for market. Proper packing for parcel post marketing is of primary importance and needs to be emphasized so that both the contents and the container may carry properly, arrive in good condition, and present a satisfactory appearance. The pack should be regular, of as nearly uniform produce as possible, and of full measure according

to the quantity ordered. A little practice will enable almost any one to pack a basket or container of any kind in a satisfactory manner.

AGREEING ON PRICES.

Not only must the farmer have something additional to the usual price to compensate him for the extra work, container, and postage required, but the consumer must also have something to attract him to marketing by parcel post. An equitable distribution of the difference between the usual farm price and the retail price is necessary. Just what portion of this difference in price is to accrue to the pro-

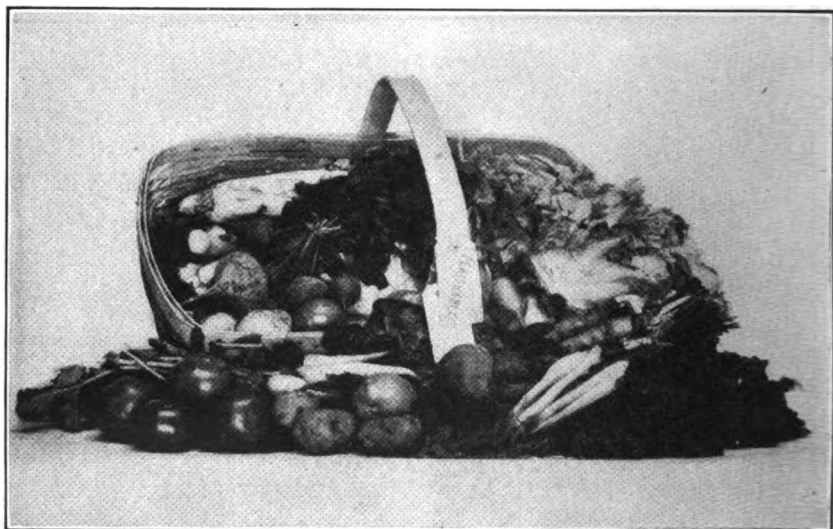


FIG. 4.—Same basket as in figure 2, vegetables displayed.

ducer and what to the consumer will depend on the circumstances in each case and the size of the order. In determining what the price shall be, both the farm price and the retail price paid by the consumer when he markets in the ordinary way should be taken into consideration. The consumer must receive either a better article at the usual retail price or an article of the grade usually purchased at some concession in price.

The fact that a large number of farmers and consumers are not endeavoring to take advantage of the parcel post method of marketing is due not so much to the absence of a desire to give it a trial as to the farmer's lack of knowledge of marketing requirements and customs and the consumer's lack of similar knowledge and of confidence in the farmer's produce and dependableness.

REMITTANCES—BUSINESS ARRANGEMENT.

A personal acquaintance should be established between producer and consumer, if it does not exist, when they come into business contact. This will help a great deal in furthering parcel post marketing, and also will eliminate many of the misunderstandings which may occur from time to time. A definite understanding should exist as to the duties of each in regard to remittances, claims for damaged or spoiled produce, and the preservation and return of containers. Monthly remittances by the consumer probably would be satisfactory. More frequent payments probably would be objectionable to the pur-

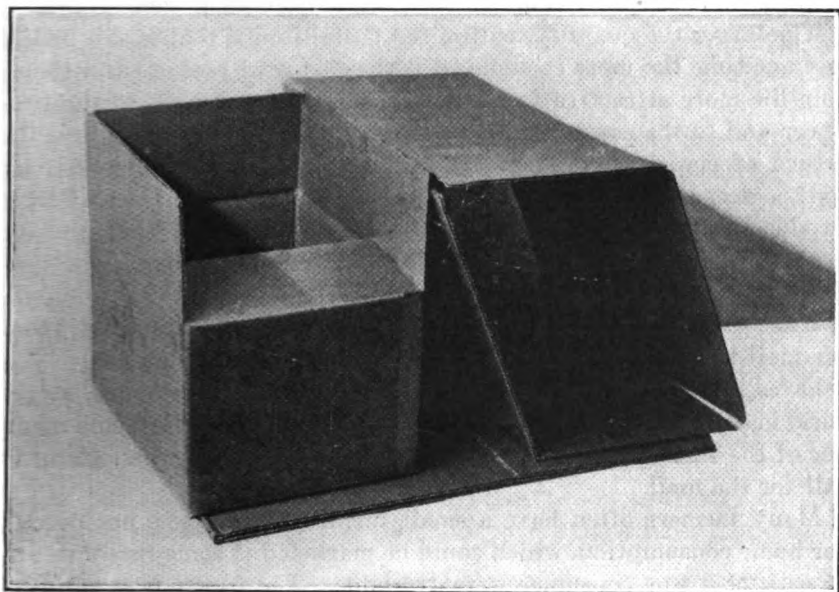


FIG. 5.—Corrugated slotted cartons. One “knocked down” flat, one (on the right) partially set up, and one ready to fill.

chaser, while the producer in most cases would not be satisfied with less frequent settlements. Consumers should remember that farmers are usually busy and not inclined to needless correspondence. Farmers should be prompt in attending to correspondence if they desire to do business.

THE ECONOMICS OF PARCEL POST MARKETING.

Parcel post as a means of transportation has been found by commercial houses to be useful and efficient. There is no reason why farmers can not make extensive use of it under certain conditions if they will. It has been found that one of the chief factors in prevent-

ing the satisfactory development of parcel post marketing has been the price asked by some farmers for produce. To illustrate: One farmer's wife was receiving 20 cents a pound for butter in her local market, a country store. When asked if she would be willing to ship it to a city by parcel post, and at what price, she replied that she would do so at 50 cents a pound. Would-be purchasers frequently have been known to offer producers a lower price than they can obtain in their local markets. It is needless to say that such imperfect and erroneous ideas as to proper and equitable prices altogether defeat the possibility of marketing produce by parcel post. Business in marketing by parcel post can be secured and held only by shipping produce of high quality and by charging reasonable prices.

The larger the quantity, within the postal limits, that is shipped at any one time the more economical is the factor of postage and therefore the more attractive from the viewpoint of cost both to the producer and to the consumer. This applies both to shipments and the return of empty containers. It would not be economical to secure half a dozen different kinds of vegetables from as many different producers, but if a supply of half a dozen kinds of vegetables, or vegetables and fruits, could be obtained in one parcel from one producer it would be both advantageous and attractive.

Another advantage to the producer in parcel post marketing is that his mail box or local post office becomes his shipping station. This relieves him from any extra trip in order to make shipment, as the rural mail carrier takes the shipment from the mail box or some member of the farmer's family deposits it at the post office when going to call for the mail.

Many farmers often have a small surplus of produce, not needed for home consumption, which could be marketed if some ready means of getting it to a consumer were available. The parcel post supplies this medium. There are also many supplemental or side lines of production which could be developed for the same purpose.

Mutual confidence and helpfulness are needed in order to succeed; cooperation is needed. Consumers are interested in buying by parcel post only when they can secure more satisfactory produce, some advantage in price, or both. The producer will not be interested in marketing by parcel post unless it means some additional net return to him. A high quality of produce, well prepared, carefully and attractively packed, and forwarded so as to reach its destination at the time desired will go a long way toward the establishment and continuance of business. Ordinary or inferior produce will not only lose a customer but hinder the gaining of others. The producer must aim to give satisfaction by supplying his customers, as nearly as possible, with produce which meets their individual desires. The con-

sumer must also aim to give satisfaction by properly caring for and returning containers, making prompt remittances as agreed upon, and by doing his part in all phases of the transaction. In other words, a square deal is needed.

QUALITY AND APPEARANCE OF PRODUCE.

It is probable that the point which will make the strongest appeal to the average consumer is that he can secure by parcel post a fresher, brighter, more attractive, and thus possibly a better product than he can obtain otherwise. Producers should remember always that the appearance of fruit and produce is one of the strongest factors in making a sale; it will not pay to market anything but standard and fancy produce by parcel post; and the surest way to establish a dependable, continuing, and increasing business is to forward nothing but strictly reliable and satisfactory produce.

The average producer, as a rule, does not realize the importance of appearance as a factor in selling goods and frequently is careless and indifferent in preparing produce for market. The consumer, on the other hand, relies very largely upon appearance in selecting food supplies, and unattractive articles are passed by promptly. Produce should be of high quality, clean and attractive, carefully and neatly prepared and packed, of one variety, and, as far as practicable, uniform in size, shape, color, and quality; and last, but not least, carefully packed to insure its arrival in a satisfactory condition.

STANDARDS OF QUALITY.

The list of fruits, vegetables, and other products treated in this bulletin is not exhaustive, but probably covers those most likely to be handled by parcel post.

All successful cooperative marketing organizations of growers and private marketing organizations have an ironclad rule that no fruit of any kind which has fallen to the ground shall be picked up and shipped. It is even more important that this rule should be observed in parcel post marketing. Producers should at all times strive for uniformity in the products shipped—uniformity of size especially, and also of color and quality. Figure 6 shows three bunches of asparagus of uniform size and quality, neatly tied; also a quantity of loose asparagus, quite variable in size and quality, which would not sell well. The same general principles which applied in the selection and grading of the bunched asparagus should apply to the preparation and grading of all other produce.

It may be stated that as a usual proposition it is feasible to ship only the produce that is of high value in comparison with its weight. In any case, the net returns will be the determining factor; only gen-

eral facts can be stated in this connection. In family baskets or containers, or in assorted lots of vegetables and of fruits, there is likely to be a demand for the inclusion of many of the heavier articles, such as potatoes, cantaloupes, cabbage, and onions, the shipment of which alone might not be justified.

POULTRY.

All poultry should be carefully picked to avoid torn flesh, and all pin feathers removed. Dry-picked poultry usually presents a much better appearance than that which is scalded. It is very important that poultry be thoroughly cooled before shipping. If desired, the head and feet may be left on, but in parcel post marketing it is more economical to ship with heads and feet off. If heads are left on, they

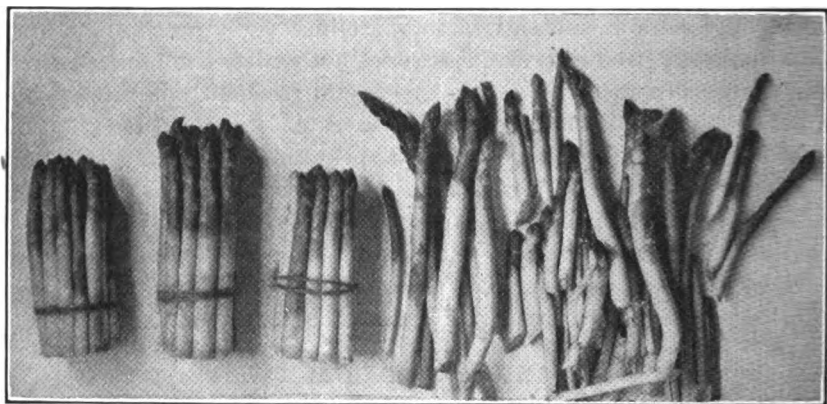


FIG. 6.—Asparagus properly and improperly graded and prepared.

should be neatly wrapped in parchment paper. If removed, the skin of the neck should be first drawn back, so that after the head is taken off the neck skin will completely cover the neck. This should then be tied and wrapped in parchment paper. Poultry ships and keeps much better if undrawn. It should not be drawn unless the customer insists on having it that way or unless State or local law requires it. No diseased poultry should be offered for sale. It is desirable to offer only plump, well-fattened birds. Old stock of doubtful eating quality should be disposed of in some other manner.

Dressed poultry may be roughly divided as follows: Chickens, hens, ducks, geese, and turkeys. The term "chickens" includes broilers, fryers, and roasters. Some dealers draw the line between chickens and hens as that age at which the end of the breast bone will not give under pressure, but is found firm.

Broilers usually weigh from 1 to 2½ pounds, fryers from 2 to 3½ pounds, and roasters from 3½ pounds up.

Hens for roasting must be in desirable condition and not so old that the flesh is not tender. Hens for stewing may include roasters as well as the older fowls.

Old roasters should not be marketed by parcel post, as they are not of a satisfactory quality.

Turkeys may be classed as young hens or toms and old hens or toms.

Ducks and geese should be sold at such an age and in such condition as required by the customer.

BUTTER.

Shipping butter by parcel post is fully treated in a bulletin now being prepared for publication and which will be announced when issued.

EGGS.

Farmers' Bulletin 594, "Shipping Eggs by Parcel Post," discusses this subject fully. This bulletin can be obtained from the Division of Publications, United States Department of Agriculture.

FRUIT.

Apples.—Apples are probably our most important fruit crop and lend themselves readily to parcel post marketing. There is a promising field for developing marketing of fancy eating apples direct from producer to consumer, and every grower should ascertain for himself if he can profitably make this system supplement other methods of marketing. It is necessary, of course, that satisfactory markets be available within a reasonable distance and that local conditions be favorable.

Only varieties of well-known merit for eating purposes should be marketed. They should all be well-grown specimens, of proper shape and size for the variety, of normal color, ripe enough to eat (unless the customer wishes to hold them), but never overripe; that is, they should be marketed in their proper season. They should be sound, clean, free from damage of worms or other pests, disease, skin puncture, or other defects.

Berries.—All berries should be shipped as soon after picking as possible. They should not be held over from day to day. They should be picked only when dry, be removed from the sun, and kept as cool as possible. Defective and cull berries should be kept separate as the fruit is gathered to avoid further handling for the purpose of sorting. Rehandling does great damage to berries as well as to cherries and currants.

Strawberries.—Strawberries may be picked when sufficiently ripe to reach the consumer in good condition. They should be picked with the hull or cap and the stem on, the stem being pinched off as close to the berry as convenient. The berries should be placed in the

boxes as picked instead of being held in the hand until a handful is gathered. Small, inferior, dirty, and overripe berries should be placed in separate boxes as picked, but should not be sent to market. The quality and size should be the same from top to bottom and the boxes well filled. Topping or facing the boxes with the larger fruit should not be done, but turning down the stems of the top layer improves the appearance of the package. No leaves, sticks, long stems, or other trash should be allowed to get into the boxes.

Dewberries and blackberries.—Dewberries and blackberries should be picked only when dry and handled as little as possible. They are ripe enough when a full, bright black, but for parcel post marketing should not be allowed to become too ripe. All undesirable ones should be kept out as the berries are picked.

Raspberries.—Special care must be taken to see that raspberries are picked only when dry and while they are still firm. They should be carefully handled, graded as picked, and never rehandled. Boxes should be well filled, as they have a decided tendency to settle down in shipping because of their cuplike shape.

*Cantaloupes.*¹—If for use within 48 hours, cantaloupes should not be picked until they are fully netted and will part from the vine clean; that is, a "full slip" without tearing the flesh of the melon. They should be "hard ripe," not full ripe, yellow, or mushy. They require just as careful handling in the field or packing house as peaches, pears, and other soft fruits, to avoid bruising, and therefore should be brought from the field in baskets or crates, not loose in the wagon. All poorly netted or smooth melons should be discarded, also all cracked, ill-shaped, overripe, or immature melons and those with soft ends or other defects.

Cherries.—All cherries must have the stems on and when possible should be clipped from the tree with scissors instead of being pulled. Cherries pulled from the stem decay quickly. Soft, bruised, overripe, bird-picked, and all other defective fruit should be kept out.

Currants.—Currants should be picked before becoming overripe. They grow in clusters, and unless the stems are fairly full they should not be put in the boxes. Avoid shipping any unduly small, shriveled, or mashed fruit. As currants mold easily, they should be picked and kept cool and dry and marketed quickly.

Grapes.—For eating purposes grapes should be allowed to become ripe, and only those of desirable size should be shipped. Dried, shrunken, cracked, mildewed, or otherwise defective grapes should be trimmed out or the entire cluster discarded. Only full, attractive clusters should be shipped for table use.

¹ For directions regarding the preparation of cantaloupes for market see: More, C. T., and Branch, G. V. The commercial grading, packing, and shipping of cantaloupes. Farmers' Bulletin 707.

Peaches.—It is very important that peaches be handled carefully at all times to prevent bruising. For shipment by parcel post they should be about ripe, but only “hard ripe,” ready to eat in not less than two days. Varieties and colors should not be mixed unless so ordered. They should be smooth, well-colored, entirely free from worms, blemishes, split pits or seeds, bruises, disease, or other defects, and of good size for the variety.

Pears.—Pears should not be picked so ripe as some other kinds of fruit, because they bruise and turn black so easily. In fact, it is advisable to pick most varieties when matured, though green, or just starting to ripen. If picked when just turning, they should reach the consumer about right to use. They should be free from worms, bruises, and cuts, practically free from disease, specks, blemishes, and other defects, and should be of proper shape and size for the variety. No fruit off the ground should ever be shipped.

Plums.—Plums may be picked so that they will reach the consumer just ready to use. Careful handling will prevent decay in shipping. Undersized fruit should be sorted out. Cracked, ill-shaped, off-colored, or otherwise defective plums should be culled out, and no overripe fruit should be overlooked, for a decaying plum wets all those around it and causes them to rot.

VEGETABLES.

Asparagus.—Asparagus should be cut often enough so that it does not become tough or overgrown. The tops should not be wet, as this starts decay, and all imperfect stalks should be culled out. It should be carefully tied in half-pound or pound bunches, with the tops all even and the bottoms trimmed off square. It improves the appearance of asparagus to wrap it in parchment paper.

Beans (snap beans).—Beans, whether bush or pole varieties, should be picked when free from rain or dew, while tender, crisp enough to snap, and before the seed is large enough to bulge the pod very much. The size of the seed will vary with the variety, but both pod and seed must be tender. Any defective, rusty, insect-eaten, discolored, or undesirable beans should be kept out. They should be fresh picked when shipped. Only varieties which are entirely or practically free from strings should be grown for parcel post marketing.

Cabbage.—Only perfect, hard heads of cabbage should be considered for parcel post marketing. They should be carefully trimmed of waste leaves and stalk, and soft, growing, bursting, frozen, or decaying heads must be eliminated. A variety producing small to medium-sized firm heads should be selected.

Cauliflower.—The heads of cauliflower should be very carefully handled when cut and after having been cut. In trimming, at least

one circle of the large outer leaves besides the smaller ones beneath should be left to protect the head. Paper is sometimes placed over the head for further protection and tucked down inside the leaf stems. All heads must be compact, and any inferior, discolored, insect-damaged, or otherwise defective ones should not be shipped. To be of the most desirable eating quality, cauliflower should be used by the consumer as soon after cutting as possible.

Celery.—Only firm, fresh, well-bleached, clean celery should be shipped. It should be washed and well trimmed of roots, loose and diseased or discolored leaves, and stems. The stalks should be of one length and practically uniform in size. They should be freed from water as thoroughly as possible and wrapped in paper.

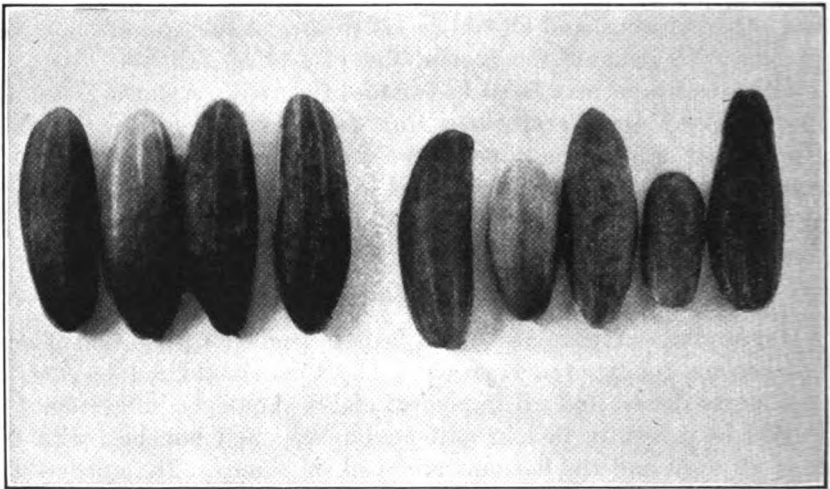


FIG. 7.—Four cucumbers on the left practically uniform in size, shape, and coloring. These are much more attractive and salable than the five irregular and defective specimens (culls) shown on the right.

Cucumbers.—For slicing, only the long, straight, smooth, green cucumbers from 6 to 9 inches in length should be shipped. The spongy, thick, yellow, runty, or overlarge ones, or those having wilted or shrunk ends, should be culled out. The cucumbers should be cut and not pulled from the vine.

For pickling, cucumbers should be of the size desired by the customer, such as “midgets,” the very small ones, 2-inch, 3-inch, dill-pickle size, etc.

Eggplant.—Eggplant should be cut when the fruits are of proper size, but should not be allowed to become tough. Undesirable sized, off-color, wilted, or defective ones should be discarded. The fruit should be wrapped in paper and carefully packed.

Green corn (sugar).—The sooner sugar corn is eaten after gathering, the better its eating quality. No inferior ears should be shipped. All should be well developed, free from worms, and gathered at the proper stage of development; that is, in full milk, but before showing any signs of firmness or toughness.

Kale. (See Spinach.)

Lettuce (head).—Consumers prefer firm, well-headed lettuce. It should be well developed and the heart turning white before cutting. It is best to ship only lettuce which is free from dirt, and no discolored, insect-damaged, or imperfect heads should be included.

Lettuce (loose leaf).—Some varieties of lettuce do not produce heads but instead a loose cluster of leaves. It should be cut when of good size, but tender and crisp. Trim off the outside, discolored, and otherwise unattractive leaves. Lettuce should be dry when packed.

Onions (dry).—All onions should be ripe, well cured, dry, and clean. It is well to ship only those of uniform size and shape. No sprouted, frozen, or otherwise defective bulbs should be marketed.

Peas.—Growers should allow peas to mature properly; but, of course, consumers do not want hard, ripe peas. They should be cool and dry when picked and packed to avoid heating and molding. Immature, dirty, or defective pods should be discarded.

Peppers (sweet).—The sweet varieties of peppers should be well grown and of uniform size and color. No wilted, cracked, or dirty fruits should be included. They should be crisp and dry when shipped.

Peppers (hot).—Hot peppers may be supplied according to the desires of the consumer.

Potatoes.—Occasionally it may be found profitable to market potatoes in small quantities by parcel post. They should be of good grade, one variety, clean, smooth, sound, and of a good table variety. Those affected with sunburn, disease, second growth, cuts, and bruises should be culled out. No potatoes less than 2 inches in diameter should be shipped, and a uniform run of size is very desirable.

New potatoes should be of good size, preferably not less than 2 inches in diameter and equally as free from defects as old ones.

Root vegetables.—Root vegetables, such as beets, carrots, parsnips, and turnips, should be tender, fresh, sound, washed clean, and of desirable size. No overgrown, stringy, coarse, or undersized stock should be marketed.

Sweet potatoes.—Sweet potatoes should be of good shape and color, clean, sound, bright, and of good size. Overgrown, coarse potatoes are not wanted. It is desirable to market stock of as near an even size as possible, and the medium size is preferred. As sweet potatoes

spoil easily, they should be handled carefully to avoid bruises and cuts. Chilling injures their keeping qualities.

Spinach and kale.—Spinach and kale should be free from sand, dirt, and insects. They should be of good green color, without yellow, decayed leaves, or seed stalks, and of proper size according to the season and the market supplied.

Tomatoes.—Great care should be taken in picking, handling, and packing tomatoes, so that they do not get bruised, cracked, or mashed. They should be picked without stems to avoid the bruising of other fruit by the stems when packed. If they are for immediate use, they should be ripe, but very firm; if they are to last the consumer several days, some should be picked “hard ripe” and others beginning to

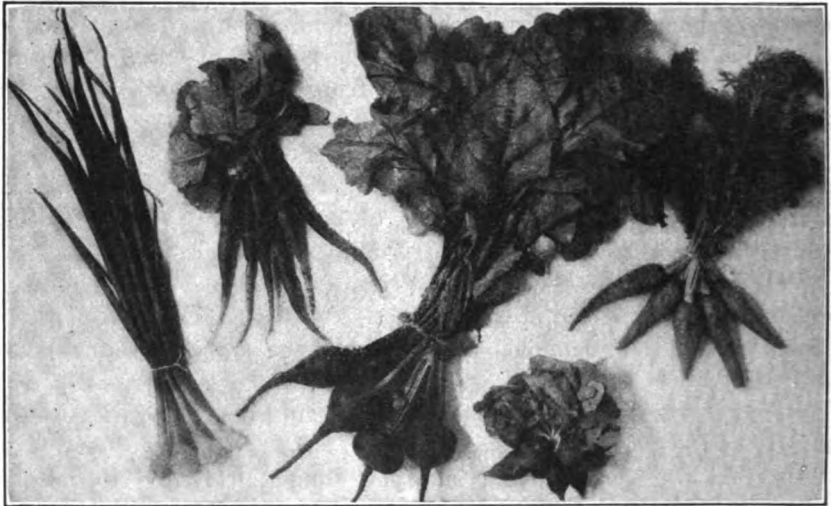


FIG. 8.—“Bunched” vegetables. From left to right : Onions, long radishes, beets, round radishes, and carrots.

ripen. No ill-shaped, split, curly, wormy, or otherwise defective tomatoes should be shipped for eating purposes.

It is desirable that fruit shipped should be fairly uniform in size unless it is to meet special requirements of the customer. If shipped with other fruits or vegetables, tomatoes should be so packed that nothing else can mash them.

“BUNCHED” VEGETABLES.

Some vegetables, such as radishes, onions, new beets, carrots, turnips, salsify, watercress, and parsley, are tied in bunches for marketing. Occasionally it may be desirable to bunch them for parcel-post marketing, as shown in figure 8.

“Bunched” vegetables should be of proper size, according to the season and the market custom, and should be neatly and carefully bunched. The number in each bunch varies on the different markets and according to the kind of vegetables. The first five named are usually shipped with the tops on. If the bunches are broken or if they are not bunched in order to facilitate packing, the count and grade should be the same as if they were shipped in bunches.

FARMERS' BULLETINS OF INTEREST TO VEGETABLE AND BERRY GROWERS.

- Farmers' Bulletin 255. The Home Vegetable Garden.**
- Farmers' Bulletin 647. The Home Garden in the South.**
- Farmers' Bulletin 289. Beans.**
- Farmers' Bulletin 433. Cabbage.**
- Farmers' Bulletin 282. Celery.**
- Farmers' Bulletin 254. Cucumbers.**
- Farmers' Bulletin 232. Okra.**
- Farmers' Bulletin 354. Onion Culture.**
- Farmers' Bulletin 407. The Potato as a Truck Crop.**
- Farmers' Bulletin 324. Sweet Potatoes.**
- Farmers' Bulletin 220. Tomatoes.**
- Farmers' Bulletin 642. Tomato Growing in the South.**
- Farmers' Bulletin 460. Frames as a Factor in Truck Growing.**
- Farmers' Bulletin 643. Blackberry Culture.**
- Farmers' Bulletin 213. Raspberries.**
- Farmers' Bulletin 198. Strawberries.**
- Farmers' Bulletin 664. Strawberry Growing in the South.**

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UNITED STATES DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 704

Contribution from the Office of the Secretary

Washington, D. C.



January 20, 1916

GRAIN FARMING IN THE CORN BELT

WITH LIVE STOCK AS A SIDE LINE

By

CARL VROOMAN

Assistant Secretary of Agriculture



This bulletin is written to suggest to the corn-belt farmer of the Middle West—especially the farmer whose soil has been run down by continuous grain farming—some ways of coordinating and “cashing in” the scientific advice offered him in bulletins already published



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This bulletin is written to suggest to the corn-belt farmer of the Middle West—especially the farmer whose soil has been run down by continuous grain farming—some ways of coordinating and “cashing in” the scientific advice offered him in hundreds of bulletins already published. The science of agriculture has been expounded frequently by competent scientific experts, but the practical and business end of farming has had less attention. Now while agriculture primarily is a science, farming primarily is a practical art—a business. A farm is as much a business enterprise

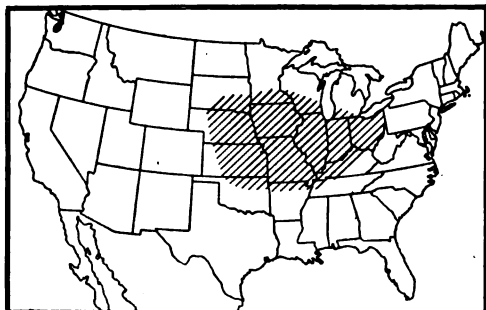


FIG. 1.—Map of the United States, showing by shaded lines the territory to which this bulletin is applicable.

as is a foundry or a cotton mill. Unquestionably it is vastly more than that. It is a *home*, a social and civic center, and the most important unit of civilization. But a recognition of this great truth should not blind us to the fact that the success of the farm home is based upon the success of the farm business. No satisfactory family life, and no satisfactory national life, can be established on other than sound economic foundations. What farmers need most to know is how to make the *science* of agriculture boost the *business* of farming.

We have been in the habit of taking the crop as a unit, printing a bulletin on corn, another on alfalfa, etc. These publications have proved invaluable, and the present type of bulletin is not intended to replace but to supplement them, and to serve as an introduction to a wider and more profitable study of them by the average corn-belt farmer.

This bulletin has been written from the standpoint of the farmer who is farming for a living—the whole farm being taken as a unit and all grain crops suitable for this section being considered in their proper relations to each other and in rotation with legumes. Theories and scientific explanations have been cut to the bone. The suggestions given are modeled upon those which for years the writer has given with good results to tenants, as to how to apply scientific methods with profit.¹

Briefly, these are the conclusions reached by our most successful corn-belt farmers and agricultural experts:

To make a money-maker of a farm that has become a losing proposition through steady grain farming you must in addition to raising standard grain crops—

(1) Grow legumes—alfalfa, sweet clover, soy beans, cowpeas, red clover, or alsike, according to your soil and climatic conditions.

(2) Raise live stock as a side line—thus saving waste in pasture, fodder, straw, etc., holding down your grain sales and keeping up the productivity of the soil.

(3) Keep accounts of receipts and expenditures—thus substituting figures for guesswork as to whether you are making money or losing it *on each crop*.

¹Among those in the Department of Agriculture who have supplied data for use in this bulletin are the following:

Edgar Brown, in charge of seed-testing laboratories; M. A. Carleton, in charge of cereal investigations; J. A. Drake, Office of Farm Management; Raymond Evans, Editor, Office of Farm Management; Prof. O. S. Fisher, Specialist in Scientific and Practical Agriculture; Dr. H. B. Humphrey, pathologist in cereal investigations; Dr. Karl F. Kellerman, Assistant Chief, Bureau of Plant Industry; Chas. V. Piper, in charge of forage crop investigations; Dr. George M. Rommel, Chief, Division of Animal Husbandry; Prof. W. J. Spillman, Chief, Office of Farm Management; Capt. W. S. A. Smith, Expert in Farm Practice; F. M. Webster, in charge of cereal and forest insect investigations, and Prof. Milton Whitney, Chief, Bureau of Soils.

While I have received invaluable aid from these and other authorities in this work, I have written the bulletin in my own way and wish to assume full responsibility for the manner in which each subject is handled.—C. V.

(4) Mix horse sense with scientific agriculture—thus adapting the new methods to changes in market, weather, and other conditions.

(5) Try to secure enough capital to enable you to farm right. Most landlords would make larger profits on their fixed investment in land and buildings if they would invest enough additional capital to provide first-class improvements, including such items as silos, tile, fertilizers, hog-tight fences, etc. Tenants likewise would get larger returns on their capital, brains, and labor if they were able to make larger investments in fertilizers, pure-bred bulls and boars, high-grade heifers and brood sows, and enough "help" to enable them to farm to the best possible advantage.

(6) Stick to whatever policy you adopt long enough to try it out. It often takes time and experience to learn to adapt new methods to local conditions. But nothing is as certain to bring failure as flopping irresolutely from one plan to another.

(7) Confer with your County Agent and make a careful study of the bulletins of the United States Department of Agriculture, and of your State Agricultural College, concerning the particular problems that trouble you.

THE SOIL.

The farmer who robs his soil is sawing off the limb upon which he is sitting. How can productive soils be kept productive and poor soils be made more productive? On the way we solve this question, more than upon any other one thing, hangs the future of farming in America.

WHAT TO DO.

Given a run-down farm in the corn belt, the best and shortest cut to profitable yields generally is to be found through legumes and live stock. To open this short cut, however, we must follow certain fundamental rules in handling the soil.

(1) *Put humus into the soil.*—That is the first move toward building up a run-down farm. Humus is the stuff with which nature fertilizes uncultivated soils—the rotted remains of dead leaves and grass, of weed stalks, fallen logs, plant roots, and the like. Without humus the soil would be merely mineral matter, just rock more or less finely ground and decomposed. Organic matter increases the water-holding capacity of the soil, and as it rots down to form humus, it furnishes organic plant food for bacteria and plants, and by chemical action increases the *available* supply of mineral plant food that comes from the fine rock particles in the soil.

To get humus, plow under all the waste vegetable matter you can obtain—all stable manure, straw, cornstalks, stubble, leaves, weeds and green manure crops, such as clover. Anything vegetable that will rot in the ground makes humus when it has decayed. Legumes should be

used for green manure crops when possible, because they add more nitrogenous plant food to the soil, whereas other green manure crops merely make the plant food on hand more available. Never burn straw or cornstalks unless absolutely necessary—it's like burning money. Spread your straw upon the field next to be plowed, or better still, use it first for feed or bedding or as a mulch for some crop like potatoes and plow it under later as stable manure or with the refuse of the crop.

(2) *Establish a sound and regular rotation of crops.*—It is difficult to make a general rule as to crop rotations, because rotations vary with local conditions, but there are some rules in this regard that hold anywhere. A two-year rotation, such as corn and oats, is entirely inadequate. Every rotation should include at least one legume crop. The rotation should be planned with the aid of your County Agent or your State Agricultural College to fit the individual farm and local conditions. (See "Rotations," p. 12.)

(3) *Select your crops to suit your soil.*—Some farms have grown crops that have depleted the humus and diminished the productivity of the soil until it is no longer possible to grow profitable crops of corn, oats, and timothy. Yet such soil often will produce good crops of some annual legume, such as soy beans or cowpeas. Where nature grows sweet clover you can grow sweet clover, too, and after you have plowed under a crop of that rank growth you have a good start on the road to fertility. Remember, there's a legume crop for almost every soil, and that no rotation is complete without a legume. Try to find the legume best suited to your soil and conditions, and then make it the basis of your rotation.

(4) *Use drain tile freely.*—Artificial drainage is a factor of great importance in soil improvement; often the factor of greatest importance. It enables us to grow potatoes or onions where nature can grow only cattails, because it insures the even distribution of both the water and air that our cultivated crops demand. Where the land lacks natural drainage, everything else depends on how thoroughly the soil is ditched or tiled.

(5) *Suit your plowing to your soil.*—As a rule, the harder the soil is to break, the deeper and the more thoroughly it must be broken up to let air in to do its work. (See "Tillage," p. 7.)

(6) *Manure as regularly as you harvest.*—Stable manure is the best form of fertilizer, because it not only adds available plant food, but also improves the physical texture of the soil. It tends to lighten heavy soil and to make sandy soil hold more water. Stable manure contains easily available plant food, both organic and mineral, and as it decays in the soil hastens the liberation of other plant food. Green manure is an excellent substitute for stable manure, and is essential to good farming where little or no live stock is kept.

Where stable manure is not available, green manure *must* be used to get results. Not merely stubble, but the entire green crop must be plowed under to make a green manure crop a good substitute for stable manure. In the case of a legume manure crop, the seed should be saved, but all the rest of the crop should be returned to the land.

(7) *Correct soil acidity with lime.*—Lime is the one thing most needed by the average run-down soil. It is perhaps safe to say that more poor crops are due to sour soil than to lack of plant food. Certainly most of the failures of clover and other legumes are due to soil acidity. On sour soils lime is needed to neutralize the acid. If your sod fields show patches of red sorrel, moss, poverty grass, and the like, scanty or sour-tasting vegetation, and if your legume crops fail to respond readily to applications of stable manure, try lime.

Crushed limestone is the best form of lime to use in ordinary farming. The limestone particles break up slowly and one application will last for several years. It should be put on at the rate of 2 to 4 tons per acre. Special spreaders are sold for this purpose. However, if one does not care to buy a lime spreader, an ordinary manure spreader may be used, by putting a thin layer of straw or coarse manure on the bottom of the spreader, with the crushed stone on top. If your spreader is set to spread four loads per acre and you wish to apply, say, 3 tons of lime per acre, then use one-fourth of 3 tons, or 1,500 pounds, of the crushed stone per load.

Burned lime may be used to advantage on gardens and on soils abnormally rich in humus, such as peaty loam. A little over a ton per acre will equal 2 tons of raw stone. Burned lime should never be used in ordinary farm practice on normal prairie soils, as it tends to burn out the humus. Crushed limestone does not have this effect.

Experiments with lime and limestone made by the University of Illinois show a gain in yield of \$2.64 per acre per year at a cost of 50 cents per acre per year on soil treated with lime in some form (145 tests, covering six years). (Circ. 110, Illinois Experiment Station.)

Burned lime brings bigger yields for a few years, but crushed limestone is best in the long run. The Pennsylvania Experiment Station tried burned lime and limestone side by side on the same soil for 30 years, and during that time the plats treated with the raw stone produced 2.6 tons more of hay, 22 bushels more of wheat, 106.7 bushels more of corn, and 154.7 bushels more of oats per acre than the plats treated with burned lime. In 1908 the Pennsylvania Experiment Station started work comparing the effects of equivalent amounts of air-slaked burned lime and raw ground limestone on a rotation of corn, oats, wheat, and hay (clover and timothy). After six years' test the air-slaked lime gave a total increase over the untreated check plat of

\$2.69¹ per acre, against an increase of \$7.93 per acre for the plat treated with raw ground limestone. This gives a balance of \$5.24 per acre in favor of the raw stone. The increase of \$2.69 per acre on the plats treated with air-slaked lime would just about pay the cost of the treatment, while the increase of \$7.93 per acre for the raw limestone rock gives a net profit of a little over \$5 per acre. (Penna. Experiment Station, Bulletin 131.)

It is most economical to buy limestone in car lots. It is not necessary that the crushed stone be finely ground; what is known as screenings, containing, with the coarser pieces, all the dust made in grinding, will do. The stone commonly used for the top dressing of limestone roads is a little coarse for liming soil, but if the dust is not screened out it will do in a pinch.

The cost of crushed limestone in the corn belt, delivered on your nearest siding, varies with your distance from the nearest quarry. In most cases it runs from \$1 to \$2.50 per ton. A carload varies in weight from 30 to 50 tons, according to the size of the car.

(8) *Use phosphates when needed.*—Phosphorus, next to lime, is the mineral plant food probably most needed by the average unproductive soil. There are three forms of phosphorus in common use—finely ground rock phosphate (floats), acid phosphate, and steamed bone meal.

Rock phosphate comes from the phosphate beds of the southeastern States, and costs the corn-belt farmer from \$6 to \$8 per ton, including freight. It should analyze from 12 to 15 per cent phosphorus. Rock phosphate should be ground so fine that at least 90 per cent of it can be washed through a 100-mesh wire sieve.² Rock phosphate should be applied at the rate of from one-half to two tons per acre, and should be used in connection with stable manure or green manure crops, as the decaying organic matter is *necessary* to liberate the phosphorus from the rock. Like limestone, rock phosphate should be brought by the carload. The most economical way to handle it is to haul directly from car to field. When the distance from the siding to the field is not over 2 miles, three men with teams and wagons can easily unload and spread a carload of rock phosphate in two days. Two men can haul while the third spreads, the third wagon always being left standing in the field from which to fill the spreader, while the other wagons are loading or on the road. It is usually best to have a regular crushed-rock spreader for this work, but an ordinary manure spreader may be used. (Follow plan for spreading crushed limestone, p. 5.) When it is not convenient to apply the rock phosphate directly to the field, it may be stored in the barn or stable and later

¹ Corn, 50 cents per bushel; oats, 32 cents; wheat, 80 cents; hay, \$10 per ton; stover, \$2.50 per ton.

² A sieve with 100 holes to the running inch, or 10,000 to the square inch.

distributed with stable manure, either by spreading from 100 to 150 pounds on each load of manure when hauling to the field, or by dusting the stable gutters with it and mixing it with the manure as it is made.

Acid phosphate is made by treating raw rock phosphate with sulphuric acid, thus producing a mixture which usually contains from 6 to 7 per cent of phosphorus, and costs \$12 to \$15 per ton, including freight. This phosphorus is more available than that in the raw rock, and acid phosphate may be used to a certain advantage without the addition of fresh organic matter to the soil treated. Where quick results are desired, or where not enough manure is to be had, acid phosphate may be used with good effect. It is usually applied at the rate of 300 to 400 pounds per acre. Use a regular fertilizer spreader, or a fertilizer attachment on a drill. If a machine is not handy it may be scattered broadcast by hand.

Steamed bone meal is made by grinding and steaming bones from slaughter and packing houses. It ordinarily contains about 12½ per cent of phosphorus in a very available form and costs from \$25 to \$30 per ton, including freight. Thus the phosphorus in it costs approximately the same as in acid phosphate. Steamed bone meal should be applied at the rate of 200 to 250 pounds per acre and should be handled the same as acid phosphate.

When soil contains an ample supply of organic matter and the object in buying phosphorus is to increase the supply of this element in the soil at the lowest possible cost, this can be done by purchasing finely ground rock phosphate. On the other hand, if the supply of organic matter in the soil is limited or you are anxious to get quick returns from the phosphorus, it is advisable to purchase either acid phosphate or steamed bone meal. As a ton of rock phosphate contains generally about 250 pounds of phosphorus, when sold at the average market price the phosphorus in it will cost the farmer about 3 cents a pound. Acid phosphate generally contains about 125 pounds of phosphorus to the ton and steamed bone meal about 250 pounds to the ton, and when sold at the average price the phosphorus in either of these forms generally costs from 10 to 12 cents a pound.

In spreading phosphorus in any form try to make the application as uniform as possible rather than to put it directly into the hills or rows. Thus it will be everywhere available to the small feeding roots that are distributed throughout the surface soil. (For fuller details on soils, see Farmers' Bulletins 245 and 406; for fertilizers, see Farmers' Bulletin 278.)

TILLAGE.

Tillage is plowing, harrowing, dragging, disking—anything done to stir the soil, either before or after the planting of the crop. As farms become older and fertility declines tillage becomes more and

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more important until on "worn-out" farms it becomes the factor of chief importance in the production of crops.

The principles of good tillage are practically the same for all conditions:

(1) Stirring the soil breaks it up. The smaller the particles of soil the greater the area the root hairs or "mouths" of the plant have to "graze" on. Good tillage gives the crop more soil surface on which to feed without increasing your taxes.

(2) When fresh vegetable matter is present, stirring the soil tends to make more plant food available. The organic matter is brought into closer touch with the mineral particles of the soil, and plant food is set free by chemical action as the vegetable matter rots down.

(3) Air is as necessary for the roots of plants as for the leaves. Plants die if there is no air in the soil. Tillage aerates the soil, supplying oxygen, which is used directly by the soil organisms, and nitrogen which is used by legumes by means of the nitrogen-gathering bacteria which live on their roots. Oxygen is also necessary to the decay of vegetable matter in the soil.

(4) Tillage tends to regulate the water supply in the soil. Well-tilled soil absorbs rain more rapidly than does a hard soil, and permits a freer circulation of moisture brought up from below by capillary action, such as occurs in a lamp wick. Like a sponge, it takes water more quickly and stays moist longer than does soil that is packed hard.

(5) Tillage kills weeds.

Briefly summed up, then, we till to make a home for the growing plant, to set free plant food, to aerate the soil, to get and use moisture and to kill weeds.

HINTS ON PLOWING AND CULTIVATION.

Most old farms have been plowed at a uniform or decreasing depth for many years. Thus the top soil lies on a hard floor, or "plowpan," a few inches below the surface. This floor should be broken up. Your deed calls for the subsoil as well as the surface soil, and the subsoil is a mine of fertility and a well of water if properly utilized. An inch or two of new soil should be turned up each year till you have thoroughly broken up the "pan."

It is of far greater importance than is generally realized to plow level fields of loam soil in the fall for spring planting. The frost has a beneficial effect on fall-plowed land. The farmer who fall plows all suitable land will find in the spring that he is in the highly favorable position of starting ahead of the game. Probably no one thing is more important in farming than keeping up with your work rather than being always a few days too late to get the best results.

Hill lands have a tendency to wash if broken in the fall. Some kind of cover crop, such as clover or rye, should be sown on steep

slopes to afford protection during the winter months. In plowing hills the principal object is to plow so water will run off slowly, thus avoiding washing. Always plow around a hill so as to keep your furrow as nearly level as possible. Washing can be minimized still further by terracing. The "Mangum" system of terracing is perhaps the best. (See Bureau of Plant Industry, Circular 94.)

Do not harrow fall-plowed land until spring, when the fall-plowed land for corn should be harrowed or disked and harrowed as soon as possible after the oats are in. This kills weeds, forms a dust mulch and saves moisture that otherwise would be carried off by the spring winds. Great care should be taken, however, to keep off the ground while it is wet.

As soon as the ground is dry enough all land to be spring plowed should be well disked in order to cut up stalks and rubbish left on the ground, as well as to form a mulch for the double purpose of holding moisture in the subsoil and of hastening the drying out of the surface soil after heavy rains. Disking more than half pays for itself by making the ground plow easier and by mixing the vegetable matter with the soil, so that it will not lie at the bottom of the furrow slice and hinder the free circulation of water.

In the spring follow the plow with the harrow immediately. Do not call a day's plowing done until the newly plowed ground has all been harrowed. In very dry seasons it may pay to harrow both at noon and evening. The saving in moisture through harrowing before the ground has had time to dry out is surprisingly great, and one harrowing when the earth is loose and moist will often put it into better tilth than three harrowings after the clods have dried. If the soil is too wet to harrow immediately, don't plow.

Sandy lands need special care. Keep such soils well packed to prevent blowing. Always harrow and roll sandy land immediately after plowing. The subsoil packer, a special type of corrugated roller, seems to produce satisfactory results on such land, as it "firms" the soil and still leaves the surface mellow. When the ground is not in use for other crops, some cover crop, such as rye, vetch, or cowpeas, should be grown.

Where cornstalks are not used for winter feeding they may be plowed under as soon as the corn is husked. This gives time for the stalks to rot in the ground over winter, leaving the ground in excellent condition for seeding either oats, corn, or other crops in the spring. (For fuller details on tillage, see Farmers' Bulletin 414.)

STANDARD CROPS.

Oats.—Prepare the ground for oats as early as possible. Oats do best with an abundance of moisture and cool weather, which cause them to stool out and make a vigorous growth. It is a mistake to

think oats can make a full yield when the seeding is not properly done. Oats pay well for a good seed bed if the work is done early enough. If they are to be seeded on plowed land, the land should be double-disked and harrowed before seeding. In drilling them in, a light harrowing after seeding will put the field in excellent condition unless the ground is very dry, in which case it should be rolled before the final harrowing. If drilled in on cornstalk land without plowing, the field should be double disked before seeding to cut up the cornstalks and prepare a seed bed; then after seeding, double-harrowed and rolled if necessary.

If oats are seeded broadcast the ground should be prepared as for drilling, and then double-disked and harrowed after seeding to cover the seed. As a rule, broadcasting oats will not produce as good crops as when they are drilled.

Oats are probably the least profitable standard crop in the corn belt. As a matter of fact, most farmers in the southern part of this region lose money on every acre of oats they raise, if in figuring the cost of production interest on land values is included. It is generally conceded that oats are grown at a loss in certain sections, but the farmers grow them there nevertheless because they regard them as a necessary part of a successful rotation. While to a certain extent this is true, our best farmers gradually are learning to substitute other crops for a part of the usual oat acreage. The best known substitute crops for oats are wheat, rye, barley, alfalfa, and soy beans or cow-peas. (For fuller details abouts oats, see Farmers' Bulletins 420 and 424.)

Corn.—Do not be in too big a hurry to plant corn. Never plant in a cold seed bed. Thorough preparation of the seed bed is more important than early planting in the case of corn. Don't worry if your neighbors get their corn in before you do. They may be re-planting when you are cultivating corn ankle high. Use the disk freely before plowing under cornstalks or clover sod for corn. The ground should be double disked after plowing, lapping the disk half its width. Follow the disk with the spike-toothed harrow, and, if necessary, with a clod crusher. During dry seasons the furrow opener is a very good tool to use on the corn planter. The furrow opener is a double disk that is clamped on the planter runners, opening a shallow furrow ahead of the dropper. Thus the corn is planted below the dusty surface soil without being covered too deep. It has a moist bed to germinate in and is assured deep rooting through the filling in of the furrow as the season advances. Corn planted with the furrow opener can be harrowed after the young corn is up without damage to the young plants, as they are below the level reached by the harrow teeth.

The most effective cultivation for corn is that which is done before the crop is planted. The main object of cultivation is to kill weeds, and the best time to do this is when the weeds are sprouting. Much time and labor in summer cultivation may be saved by a free use of big tools, such as the disk, the corrugated roller, and the harrow, before planting. Such tillage kills weeds; at the same time it puts the soil in good tilth and protects the moisture in the soil from the spring winds.

If the soil is well supplied with humus, little cultivation is needed after the corn is well started, provided it does not become weedy. Weeds must be kept down, and when a heavy rain has formed a crust on the soil the surface should be broken up by shallow cultivation that does not disturb the corn roots any more than is necessary. The small feeding roots of corn are very numerous in the surface soil, where they serve to gather food and absorb moisture that would otherwise evaporate.

Soils very deficient in humus demand more frequent cultivation than soils well supplied with organic matter. Soil lacking humus tends to "puddle" under even light rains. It often is profitable to cultivate corn on such soil with a small harrow or one-horse cultivator after the corn is too big to plow with the ordinary cultivator.

Corn is one of the most profitable crops in the corn belt, provided—

- (1) First-class tested seed is planted;
- (2) Proper methods of tillage are employed; and
- (3) The land on which it is grown is suited to corn.

This last condition is frequently overlooked. But nothing is more certain than that it is a losing game to attempt to raise corn on unsuitable land. (For fuller details about corn, see Farmers' Bulletins Nos. 313 and 614.)

Wheat and rye.—Oat fields or clover sod for winter wheat or rye should be plowed as soon as possible after harvest and a fine, firm seed bed prepared. Plowing the fields soon after the first crop is removed will assist in holding the moisture in the soil and will allow the land to be harrowed and disked a number of times to kill weeds.

Wheat should not be seeded too early, especially on rich land or when it is likely to become infested with the Hessian fly. On very rich land early seeded wheat is apt to grow too rank before freezing weather. If wheat becomes so rank that it "joints," the winter freezing will kill it. Where there is likely to be infection from Hessian fly, the seeding should be delayed till after the last brood of the season is hatched. This is usually from September 15 to 25 in the central part of the corn belt. Care always should be used in the selection of seed wheat, and the farmer is advised to consult his County Agent or to write to his State Experiment Station for advice as to the

variety best adapted to his locality. The seed always should be clean and well graded. (For details about wheat, see Farmers' Bulletins 596 and 616.)

Rye can be seeded early and then used for fall and winter pasture. A very common practice is to pasture rye heavily until about May 1, and then allow it to head and produce a grain crop. (For fuller details about rye, see Farmers' Bulletin 614.)

Timothy seeding.—Timothy is still extensively used as a hay crop in some sections, although it is not as profitable a crop as alfalfa, and takes as much fertility from the soil as does corn.

Timothy is usually seeded with clover in small grain in the spring. It also can be seeded in wheat or rye in the fall and clover seeded in it the following spring. This causes a strong, vigorous growth the first season. Usually the first year after seeding the hay will be mostly clover, but the second year most of the clover will be killed out and the field will be largely timothy. The big advantage in having clover with the timothy for the first year's hay crop is the clover keeps the weeds down while the young timothy is getting a start. Timothy sometimes is seeded in the fall without a small grain crop, but weeds are likely to damage the young meadow during the first year when seeded in this way.

No matter what time in the year you wish to seed timothy, the seed bed should be prepared thoroughly and the grain crop seeded first. Then seed the timothy and harrow lightly, rolling if the soil is dry. The seed should never be covered to a great depth.

ROTATIONS.

As previously stated, a two-year rotation, such as corn and oats, never gives satisfactory results. The best that can be said for such a rotation is that it is a trifle better than no rotation. Yields do not fall to as low a level with oats between corn crops, as with corn following corn year after year; nevertheless they soon become unprofitable. Not until you get clover or some other legume into your scheme of farming do you have a rotation that pays dividends in bigger crops.

Many farmers think they are keeping up to date and farming scientifically if they have 5 or 10 acres in alfalfa and get a stand of clover on a 20 or 30 acre field once in two or three years. This is a serious mistake. *The productivity of a farm is not being kept up on a permanent basis unless annually at least one-fourth of that farm is made to grow legumes, which are either plowed under as stable manure or green manure.* We are often asked what percentage of a farm should be devoted to corn, wheat, alfalfa, etc. Owing to changing marketing and other conditions it is next to impossible to make any satisfactory answer to such a question.

Three safe rules can be given, however: First, do not, unless under exceptional circumstances, grow corn in the same field more than two years in succession; second, keep one-fourth of your land in legumes in order to maintain a proper supply of humus and nitrogen in the soil; third, feed as much of your grain as possible to live stock on the farm.

The corn-oats system becomes an effective rotation if you add a year of clover, thus:

Corn.	Oats.	Clover.
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A long series of experiments carried on at the Illinois Experiment Station show clearly the benefits of clover when added to the corn and oats rotation. In 1879 two rotations were started; one was corn and oats, and the other corn, oats, and clover. These have been continued without a change, and taking the years 1901 to 1911, inclusive, the average yield of corn in the rotation of corn and oats was 38.1 bushels per acre, while in the rotation of corn, oats, and clover the average yield of corn for the same period was 57.2 bushels per acre.

In sections where oats do not produce good yields wheat may be substituted for the oats, thus:

Corn.	Wheat.	Clover.
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The wheat is seeded in the standing corn by means of a special drill, or the corn may be cut and shocked and the wheat seeded between the rows of corn shocks. An objection to this rotation is when the stalks are left on the ground they sometimes blow down and it is not possible to drill between the rows. In this rotation wheat is usually the cash crop and the corn is fed to beef cattle or hogs, or to both. It is a good scheme to keep both. Then, the cattle make it possible to feed the clover hay on the farm, and the hogs clean up after the cattle and save the grain that otherwise would waste.

One of the best four-year rotations, known as the "Standard Illinois rotation," is the following:

Corn.	Oats with clover seeding.	Clover.	Wheat.
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In this rotation, if the clover fails, an annual legume, such as cow-peas or soy beans, may be used to fill in. One of the chief advantages of the "Illinois rotation" is that wheat follows the legume, giving

plenty of time for preparation of the wheat ground. The first growth of clover may be used as hay, or left on the land as fertilizer; the second growth of clover may be cut for hay or for seed. If thrashed for seed the clover hullings should be hauled back and scattered over the field to be plowed under. It is becoming a general practice in some parts of the corn belt to seed clover in wheat, preferably sweet clover, as it makes a rank growth after the wheat is harvested. This crop is plowed under in the fall or in the following spring. In this way it is possible to have two legume crops to plow under in each rotation and yet grow three grain crops in the four years.

If more corn is desired this rotation can be changed to a five-year rotation by adding one year of corn, as follows:

Corn.	Corn.	Oats with clover seeding.	Clover.	Wheat.
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If on the other hand the farm is badly run down and must have a large amount of organic matter and nitrogen added to the soil before corn can be raised profitably, the four-year rotation can easily be changed to a five-year rotation by letting the sweet clover seeded in wheat stand over for a crop the following year, as follows:

Corn.	Oats with clover seeding.	Clover.	Wheat with sweet-clover seeding.	Sweet clover.
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(For method of handling sweet-clover crop, see "Legumes," p. 17.)

As sweet clover is a very important crop in parts of the corn belt, the following is given as an excellent plan for growing sweet clover to be "hogged down":

Corn.	Corn.	Small grain with sweet- clover seeding.	Sweet clover.
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The first year of corn is planted on sweet-clover sod and by hogging off this crop the field is manured for the second-year corn. Rape may be seeded in the first-year corn at the last cultivation, and by letting the hogs have the run of both corn and sweet-clover fields you get a ration of corn, rape, and sweet clover that is almost ideal for fattening hogs at small cost. The corn raised the second year of the rotation may be husked to furnish grain for winter feeding and

the early spring growth of sweet clover cut for hay; the second cutting of sweet clover being thrashed for seed, the refuse being used for fertilizer. If the wheat or oats straw is fed and the resulting manure returned to the land, the unfed grain and the sweet-clover seed are the only part of the crops removed from the farm, and the humus in the soil is increased rapidly.

The following is a good short rotation for building up a run-down farm:

Corn.	Rye with clover and timothy seed- ing.	Clover and timothy.
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The rye is seeded in the standing corn and the clover and timothy is seeded in the rye early the following spring. The rye is hogged off, the hogs being turned in a fortnight after the rye is thoroughly ripe. As the clover matures, part of it is used for hog pasture and part for hay. The clover-timothy sod is then turned under for corn. By such a plan as this, all of the rye straw is left where it is produced, and all the cornstalks are cut up and worked into the soil; likewise all the manure made by the hogs in gathering the rye and corn is left in the fields. This rotation is well adapted to building up a run-down farm economically. (For details in growing the crops and handling the stock in this system, see Farmers' Bulletin 614.)

For a dairy section, where cows run on pasture, as they generally do in the Middle West, the following is a good rotation:

Corn.	Oats or wheat.	Clover and timothy.	Pasture.
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This rotation may be extended to five years by pasturing for two years.

If one prefers to keep fewer cows and grow more corn, the above rotation can be changed thus:

Corn.	Corn.	Oats or wheat.	Clover and timothy.	Pasture.
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The field for the second year of corn should, if possible, be manured.

In sections where oats are unprofitable and where the soil, naturally or through continual cropping, is poor, such crops as soy beans and cowpeas often are the salvation of the farmers. Soy beans will be found more profitable than oats very generally throughout the

southern part of the corn belt. Here is a good soy-bean or cowpea rotation :

Corn.	Cowpeas or soy beans.	Wheat.	Clover and timothy.
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Both cowpeas and soy beans enrich the soil by adding humus and nitrogen to it. They make splendid green manure, and when thrashed for seed the refuse from the thrashing can be used to advantage for bedding and returned to the soil as stable manure, or can be returned directly to the field by spreading with a manure spreader. On heavy land the soy bean is more satisfactory than the cowpea, especially in certain sections of Ohio, Indiana, and Illinois, and northward. Either of these crops may be grown for forage, pasture, or seed. There is at present a strong demand for the seed at profitable prices, or being rich in protein they make an excellent substitute for tankage in hog feeding.

When alfalfa is used in direct rotation it may be combined with corn with very profitable results, since corn often gives from 20 to 30 per cent bigger yields after alfalfa than after clover. Where alfalfa has been on the ground for several years it is possible to grow two or three crops of corn in succession with profit, especially if part of the corn is hogged down.

In planning an alfalfa and corn rotation the farm should be divided into enough fields so one piece can be plowed for corn and a new field seeded to alfalfa each year. Thus you will need at least eight fields of nearly the same size, four of which will be in alfalfa and three in corn, and one in small grain with alfalfa seeded, as follows :

Corn.	Corn.	Corn.	Small grain with alfalfa seeded.
Alfalfa.	Alfalfa.	Alfalfa.	Alfalfa.

Another way to use alfalfa is to grow it side by side with one of the shorter rotations described on the preceding pages. This puts a field out of the regular rotation for five or six years of alfalfa, when the alfalfa should be turned under for corn and another field put in alfalfa. If you have no difficulty getting good stands of alfalfa, it sometimes pays to plow up alfalfa at the end of two or three years so as to make a shorter rotation. (For method of growing alfalfa, see "Alfalfa," p. 17.)

Sandy lands require special rotations. The hardy legumes should be the basis of sandy-land rotations, soy beans and cowpeas being especially useful for this purpose. When grown for several years in succession on sandy soil, soy beans seem to gain in yield. When used thus with rye between crops as a cover crop this legume is a splendid crop for building up a light sandy soil and offers possibilities of immediate profit. If the rye is seeded as soon as the soy beans are cut, it makes a good growth before winter and furnishes much of vegetable matter when plowed under early in May.

Here is a good sandy land rotation :

Soy beans with rye cover crop.	Corn with rye cover crop.
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Thus you have a rye crop to plow under each year and a legume crop every second year.

On the better types of sandy soil clover, alfalfa, or sweet clover may be used instead of soy beans or cowpeas. The farmer on sandy soil if he is to succeed must continually plow down a large amount of green manure unless he is able to produce stable manure or buy it at a very low price.

While the rotations outlined above are not by any means all the good rotations in use, they serve to suggest ways in which legumes may be worked into our corn belt systems of farming with profit. The rotation best fitted for each individual farm can best be worked out by the farmer himself *with the advice of the County Agent and the State Agricultural College*, always keeping in mind the fact that some legume crop must be the basis from which to work in planning any rotation worth while.

LEGUMES.

Alfalfa, soy beans, clover, and sweet clover are the legumes best adapted to the corn belt. Vetch and cowpeas do well on certain sandy loams, but are not so generally profitable as the others. Red clover; formerly the stand-by everywhere, now is considered an uncertain crop in parts of the corn belt. Where it is difficult to get a stand of clover every year, farmers must resort to alfalfa, sweet clover, and soy beans. Sweet clover, looked upon as a weed only a few years ago, promises to be the salvation of soils that are too badly run down to produce red clover.

Alfalfa.—Alfalfa is one of the most profitable known crops. It is probably safe to say that the net returns from alfalfa average nearly

twice as much as those from corn. The average yield of alfalfa per acre for the United States is a little over $2\frac{1}{2}$ tons, compared with an average yield of a little over $1\frac{1}{2}$ tons of all kinds of hay. In Illinois the average yield of alfalfa (as reported by the Bureau of Crop Estimates) is 2.85 tons, which would bring \$34.20 per acre at \$12 per ton, against \$19.40 per acre for an average yield of corn (38.8 bushels) at 50 cents per bushel. On one field in Illinois, near Aledo, the 1913 crop of alfalfa yielded $6\frac{1}{2}$ tons per acre and brought a gross return of \$82.50 per acre. Another alfalfa field near Monticello, Ill., in that same year brought a gross return of \$66 per acre, against \$30.50 for corn, \$21 for wheat, and \$11.50 for oats on the same farm. Moreover, in addition to the direct money returns from alfalfa, big returns are obtained indirectly through increased fertility due to the nitrogen and the humus that alfalfa leaves in the soil.

Alfalfa is gaining in favor in the corn belt, and it is safe to assume that part of the area now occupied by some of the less profitable crops will soon be used for alfalfa. This is true especially of timothy, for a long time the standard hay crop, and of oats.

Alfalfa can be grown almost anywhere in the corn belt with good results, if the crop is handled right. If farmers understood alfalfa better the acreage would be much larger. Alfalfa should be planted on a fertile, well-drained soil, with a porous subsoil. The nature of the subsoil is very important, for alfalfa is a deep rooting crop. The roots will go much deeper in an open, gravelly subsoil than in one of stiff clay. Alfalfa can be made to grow fair crops on poor soil, but if the soil is very thin it is always advisable to put on a good coating of stable manure or grow and plow under a crop of soy beans, cowpeas, or sweet clover before seeding to alfalfa. An application of phosphorus will generally improve the yield, and lime is necessary to success if the land is sour.

On any type of soil thorough preparation of the seed bed is essential. The soil should be worked to a fine and mellow tilth on the surface, with a firm bed below to give a good foothold for the roots of the young plants.

Given suitable soil, there are four requirements for getting a stand of alfalfa in the corn belt:

(1) Well-drained land. Alfalfa must have water, but it should dig its own wells.

(2) Sweet land. Sour land won't grow alfalfa successfully. Use limestone if your land is acid.

(3) A well-prepared seed bed. There is no crop more exacting about its seed bed than alfalfa.

((4) Thorough inoculation. (See p. 24.)

If you follow these rules, the weather is about the only thing that can keep you from getting a stand of alfalfa on the right kind of soil.

Alfalfa is usually seeded broadcast and harrowed and rolled in, but a great saving in seed can be effected by using an alfalfa drill which covers all seed at a uniform depth.

For seeding alfalfa broadcast, the seed needed varies from 15 to 20 pounds per acre. When a drill is used this amount can be reduced one-third. Care should be used to secure good seed, and it is advisable to write to the agricultural college of your State for information as to the best seed adapted to your locality.

It is almost impossible to get too thick a stand of alfalfa in the corn belt. When the stand is thick the more vigorous plants choke out both weeds and the less vigorous plants and make a thick growth of fine hay with slender stalks, while a thin stand makes a rank and woody growth of very coarse hay. The yield per acre from a thin stand may equal that from a thick stand, but the quality of the hay will be inferior. Twenty to forty plants to the square foot is satisfactory and on very rich land the stand may be even thicker and still make a good growth. If a very thin but uniform stand is secured, it may sometimes be reinforced to advantage by working the ground to kill weeds and seeding again among the older plants, harrowing and rolling to cover the seed. However, the success of this method depends largely on the weather. If the seeding is done when there is plenty of moisture, the second seeding has a good chance, but if the weather is dry, the young plants often fail to get a foothold. For this reason, it is usually advisable to plow up the field and reseed if the stand is not satisfactory.

Alfalfa makes good pasture for many farm animals, but owing to the difficulty of getting and keeping a stand, it should be grazed sparingly, and not at all during the first year. Close cropping and tramping of the soil by live stock in muddy weather does serious damage. Cattle and sheep tend to bloat when first turned on alfalfa, hence great care should be taken in pasturing these animals. Hogs do well on alfalfa—indeed, alfalfa pasture, supplemented by a small ration of corn, makes pork about as fast and as cheaply as it can be made. You can pasture several hogs to the acre, allowing them to run at will over the alfalfa meadow without interfering seriously with the regular cuttings. Thus, in addition to the hay crop, you get at least seven months of hog pasture.

Alfalfa is an excellent crop to use in clearing the soil of insects that are harmful to corn and other grain crops. The corn root aphid, white grubs, and other insects that are so injurious to corn will not feed on alfalfa, and after a field has been devoted to alfalfa for three or four years it will be practically free of them. Alfalfa is

also of assistance in getting rid of noxious weeds. Because of the frequency with which it is cut even such weeds as wild morning glories and Canada thistles can be cleaned out of heavily infested fields by cropping in alfalfa a few years. (For fuller details about alfalfa, see Farmers' Bulletin 339 or the bulletins on alfalfa issued by your State Agricultural College.)

Clover.—Clover is still a standard crop in the northern part of the corn belt, where the harm done by drought and hot sun is less than farther south. Medium red, mammoth, and alsike are adapted to certain sections of the corn belt. Crimson clover is unsatisfactory in this region. Medium red and alsike are best adapted for hay. In building up soils it is a good practice to leave, for turning under, as much of the clover as possible. If clover does not make a heavy growth, the part of the spring crop not used for hay may be clipped and left on the land and the second crop cut for seed. The clover hullings should then be spread over the field before plowing. Another plan would be to seed as much red clover as can be used for hay and then seed mammoth clover on the part of the field on which the crop is to be left and plowed under as green manure. Mammoth clover may be cut for seed and also used for green manure by rolling the crop a few days before cutting. The heads then stick up and make a short growth before maturing, and can be cut with a buncher attachment to a mower, leaving a long, prostrate stubble on the ground to be turned under. Alsike is adapted to soils too wet for red clover. It is also good as a mixture with timothy or mammoth clover. In most regions clover does not need inoculation as does alfalfa; however, fields that have not been planted to clover for several years should be inoculated to insure good results. Failure to inoculate, acid soil, and lack of humus in the soil have been the causes of most failures to get a stand of clover. (For fuller details about clover, see Farmers' Bulletin 455.)

Sweet Clover.—Sweet clover is a biennial and is a promising legume for building up poor soils. It makes a big growth on poor soils, and with proper inoculation and plenty of limestone you are almost certain to get a stand. It does not suffer from dry weather as does red clover, doesn't demand as rich a soil as does alfalfa, and makes a heavier growth than either. Sweet clover, like red clover, should be sown in the spring with a grain crop. The hulled seed is the best, and should be seeded at the rate of from 8 to 10 pounds per acre. If the hulls are on the seeds, a heavier seeding is necessary, as the unhulled seeds do not germinate readily. Sweet clover will grow almost anywhere, but it needs lime to make the largest yields. Inoculation is usually necessary. As sweet clover has the same nodule-forming bacteria as alfalfa, soil from an alfalfa field will inoculate sweet clover, and sweet-clover soil will inoculate alfalfa. Stock must be taught to eat sweet clover; when

starved to it, animals soon acquire a taste for it if mixed with other hay or seasoned with a sprinkling of salt water. Sweet clover should be cut before it gets woody and *should never be cut close to the ground*, since the new stems spring from the base of the old stalk and not from the crown of the root, as with alfalfa. (For fuller details about sweet clover, see Farmers' Bulletin 485.)

Soy Beans.—Soy beans are a splendid legume crop with which to fill in when clover or other crops fail, or for building up thin, sandy soil. At present they bring the largest money return when sold for seed, but are a profitable crop, either cut for hay, used for pasture, hogged down, or fed as concentrates. This crop is usually planted a little later than corn, on ground prepared as for corn. Whether sowing solid or in rows, use from four to five pecks of seed per acre. Inoculation is necessary when starting soy beans on a new field. A grain drill is the best tool for seeding soy beans. If they are to be cut for hay, and the land is not very weedy, the beans may be seeded solid, with all the drill hose running; but if for seed, or if the land is foul, it is best to seed in rows. This may be done by closing part of the drill hose. To seed rows 21 inches apart (the usual distance) leave one of the outside hose open, stop the second and third, leave the fourth open, and so on across the drill. A marker, such as is used on a corn planter, may be rigged up to insure accurate spacing.

When soy beans are seeded in rows, the plants will usually make a better growth and produce more seed than when sowed solid, as they not only have the advantage of cultivation, but also get more sunlight than do the plants when drilled solid.

Soy beans may be cultivated with a weeder either when seeded solid or in rows, and the cultivation continued till the blooms begin to appear. If the beans are seeded in rows and the land is very foul, additional cultivation may be given by using an adjustable one-horse cultivator.

Cut soy beans for hay while the leaves are still green and with the beans in the "dough." For seed, cut after the leaves are well ripened and beginning to fall and the seed pods well dried and almost ready to open. If allowed to stand too long, however, a large percentage of the beans will shatter out in handling. Cut for hay with an ordinary mower and rake and bunch as soon as the vines have wilted. It takes several days of bright drying weather to cure the hay so that it can be stacked safely or put in the mow. Cut for seed with the binder, if the vines are tall enough, otherwise use a mower, preferably with a buncher attachment. If you have no buncher, use the mower and follow immediately with the rake. Handle the vines as little as possible.

Soy beans are easily thrashed with either a bean huller or a common thrashing machine. If the latter is used, all the concaves should

be removed and the cylinder run at about half-speed. Thus few beans will be cracked, yet if a good current of wind is kept on the riddle the beans will be well cleaned.

Care should be taken to let soy-bean seed dry thoroughly before putting away in tight bins, as they contain a large amount of moisture.

Another way to handle soy beans is to drill them with corn and then hog off both together. This makes approximately a balanced

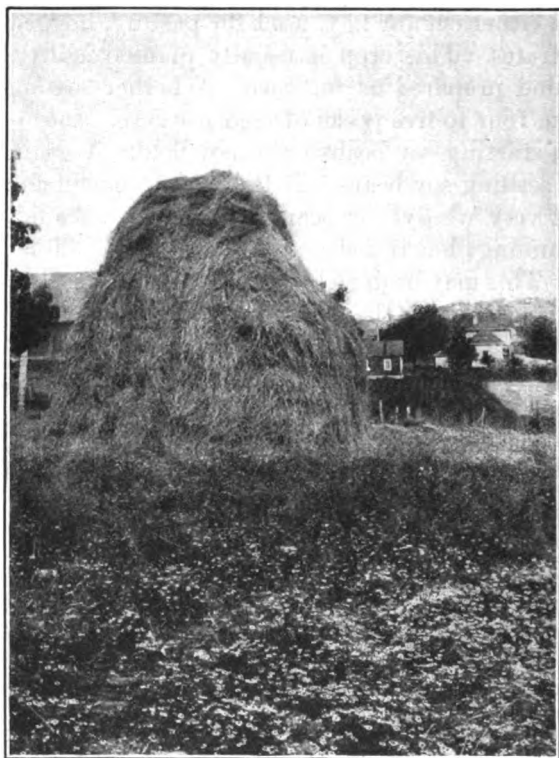


FIG. 2.—Haystack that will settle lopsided.

ration, which serves admirably for hog feed. A field planted in this way is almost sure to give a good cash return. A farmer in Champaign County, Ill., hogged off 40 acres of corn and soy beans in 1914 and found that the field gave him a net return of \$9.60 per acre more than any other field on his 800-acre farm. (For fuller details on soy beans see Farmers' Bulletin 372.)

Cowpeas. — Cowpeas are grown extensively in the southern part of the corn belt, and on poor or sandy land

in other parts. Cowpeas vine more than do soy beans and are especially useful for hay or as a green-manure crop. They should be planted, cultivated, and harvested like soy beans. (For fuller details about cowpeas see Farmers' Bulletin 318.)

HINTS ON CURING HAY.

A word on curing alfalfa and clover hay.

Cure your hay in the windrow or in the cock, never in the swath. Otherwise you will lose the best part of your crop—the leaves. Use a side-delivery rake if you wish to cure in the windrow. The sun and air can not get into the bunch made by an old-fashioned rake.

In very warm weather, when the air is dry, it is often possible to rake alfalfa or clover hay on the afternoon of the day it is cut.

After a rain, never shake out the windrow with a fork. If you do, you will lose the leaves. Leave the windrows alone till the sun dries them out on top, then flip them over lightly with the rake. If the hay is in the cock, and gets very wet, it may be necessary to open the cocks a little with a pitchfork, but do this very gently.

Extreme care should be taken to avoid putting legume hay in the mow while damp, as it molds readily. When absolutely necessary to put such hay away while a little damp, the formation of mold may be prevented to some extent by sprinkling a little salt on the hay as it is put into the mow.



FIG. 3.—Well-built haystacks.

When it is necessary to stack outside, build your stack so that the hay will keep. A common and mistaken practice is to begin drawing in the stack practically from the ground, so as to give it a long slope to the peak. As it is difficult to pack the hay in a stack evenly on all sides without unloading first from one side and then from another, such stacks usually settle lopsided (see fig. 2) and as a result the rain falling on the upper side is likely to penetrate deeply into the stack. If, however, the stack is built up straight from the bulge and then finished with a peak (see fig. 3), the greater portion of the hay will be well protected from rain. However, unless it is absolutely necessary, do not stack either alfalfa or clover without using a cover of some kind. Legume hay does not shed water readily, as does timothy or red top, and in the best of stacks there is always a large percentage of damaged hay, usually representing a loss of more

than enough to pay for a cover for the stack. (For fuller details on hay, see Farmers' Bulletins 362 and 508.)

INOCULATION.

Each legume has a sort of working alliance with a certain kind of microscopic creature which lives on the roots of the legume and pays rent by gathering nitrogen from the air. Sweet clover and alfalfa



FIG. 4.—Nodules on roots of one and two year old alfalfa plants.

have the same bacteria, but in general each legume has a different kind. Inoculation, in this connection, means putting into the soil the right kind of bacteria to help the growth of the desired crop.

There are two ways of inoculating: (1) Field-soil inoculation and (2) pure-culture inoculation.

Field soil inoculation is accomplished by putting inoculated soil from a field on which the crop is well established upon a field to be seeded or upon seed to be sown. Soil from a thrifty alfalfa field or

from a volunteer patch of wild sweet clover may be used for inoculating new alfalfa fields or sweet-clover fields; soil from red-clover fields for new red-clover fields; soil from soy-bean fields for new soy-bean fields; and so on through the list of legumes. Such soil, well sifted, can be applied to the field direct through the fertilizer attachment of a drill or broadcast with a manure spreader. If applied by drill, 200 pounds or more of sifted soil per acre will be enough. If broadcasted, 400 to 600 pounds will be needed. Great care should be taken to keep the sun from shining on the soil used for inoculation, as sunlight kills the bacteria. The soil should be sifted in the shade and should be scattered on a cloudy day or in the evening when the sun is low. After broadcasting, the fields should be harrowed immediately. When the drill is used, harrowing is unnecessary.

In gathering soil for inoculating any legume always take care to examine the plants growing where you propose to get the soil, to make sure that they have plenty of nodules on their roots, thus insuring a good supply of bacteria. (See fig. 4, showing appearance of nodules on alfalfa roots.) The soil can be kept for months in a dark basement, and for early spring seeding it is a good plan to store away in advance enough inoculated soil to inoculate the ground to be seeded.

The inoculation of small seeds with field soil is accomplished by the use of a thin glue solution: Melt 1 pound of common glue in one-half gallon of water and dilute this with warm water till you have 3 or 4 gallons. One-half gallon to 3 quarts of the thin glue will moisten about 2 bushels of seed. Put the alfalfa, clover, or sweet-clover seed to be inoculated on a tight floor or in a wagon box. Sprinkle the seed with the diluted glue solution, using a hand sprinkler, shoveling the seed over and over till all the seed have been moistened. Sprinkle the pulverized inoculated soil on the moist seed, stirring and shoveling it over and over to make sure a little of the dust clings to each seed, using about a gallon of the inoculated soil to the bushel. Allow the seed to dry in a shady place and keep it out of the sunlight till used.

Soy beans or cowpeas can be inoculated in the same way, except that the glue should be somewhat thicker. After melting the pound of glue, dilute to about $2\frac{1}{2}$ gallons. Use the same amount of liquid glue and soil per bushel of seed as for alfalfa.

Pure-culture inoculation is secured through the use of liquids in which the desired bacteria are growing. There are two methods of using these cultures. One method is to take well-sifted soil and mix the liquid culture with it, according to the directions that go with the culture, and to spread this soil on the field to be inoculated, as in field-soil inoculation. The better way is known as "seed inoculation." The seed to be treated are put into a clean bucket or tub and the pure culture is poured on, a little at a time, while the seed

is stirred and mixed with the hand till every seed has been given a thin, moist coating of the culture. After moistening, the seed should be spread upon a clean floor or on newspapers and dried. If the inoculation is done in the evening the seed should be dry enough for early morning sowing. Seed thus treated and stored in the dark can be kept for a week or more if the weather prevents immediate seeding.

Pure cultures for legume crops are supplied free, in small quantities for demonstration purposes, by the United States Department of Agriculture. Larger quantities can be bought from commercial dealers.

Pure cultures produce very good results if they are fresh and conditions are favorable. However, most of the legumes seeded in the corn belt are inoculated by the soil method. The pure-culture method costs about \$2 per acre, while the soil and glue method costs but a few cents per acre, and entails little more work than the pure-culture method except that required for gathering the inoculated soil. Since there are but few neighborhoods now where there can not be found at least one field of each of the common legumes, the soil method may be used almost anywhere.

TESTING SEED.

It is easy to test seed of all kinds, both for germination and for purity. For the germination test you need only a box that you can make in an hour. For the purity test you need only a 50-cent microscope that will enable you to count the weed seeds in a given number of clover or alfalfa seeds.

One ear of seed corn will produce about 5 bushels—if all the grains grow. If none of the grains grow—and corn is 60 cents a bushel—that dead ear is a dead loss of \$3. If you catch but one bad ear in testing, you save a good day's wages—if you find the average number of bad ones *you can save a week's wages in a winter's afternoon*. Still there are farmers who think testing seed is just a foolish scientific frill.

Testing takes only odd hours in winter or early spring, and it may make the difference between a big crop and a crop that does not pay for the labor of cultivation. When you have tested your seed you *know* that your crop will grow if conditions are right—that if you have to replant or reseed it will not be your fault.

(For further details about testing seeds, see Farmers' Bulletins 382 and 428.)

SEED CORN.

The selection of seed corn is most important in insuring a good stand and a good crop of corn. First of all, the corn should be a medium sized, early maturing variety, one that is sure to ripen in

plenty of time to escape the frost. Very few farmers realize that the price of corn and its feeding value are based on the amount of moisture it contains, and that just as large and profitable yields can be secured by growing medium sized ears that will fully ripen as by growing large ears that will not ripen, and therefore contain a large percentage of moisture.

After selecting an early maturing variety great care should be used in selecting the individual ears for seed. These should be selected in the field while the corn is still standing, just as early as the first ears are well dented. The ears should be sound, uniform in size, and well filled and should only be picked from strong, healthy stalks that have ripened as near the same time as possible. The corn should be carefully dried under cover where there is a free circulation of air.

If the seed corn is selected in this way and carefully dried, there will be very little of the corn that will not germinate. However, to be absolutely sure that the seed will grow, it should all be tested by the individual ear method.

If only a few bushels are to be gathered, use a basket or a sack. If a large amount of seed is to be gathered, it will pay to use a "seed corn boat." Nail together three planks, 2 by 12 inches by 12 feet, as you would in making a trough. Cut the ends on a slant, like sled runners, and close the ends with short pieces of board. Thus you have a "boat" that can be drawn between two rows of corn by one horse. In using the boat two men can gather the seed ears from two or three rows on each side of the boat. The use of crates that will slip into the boat will save one handling of the corn. The boat itself will hold about 4 bushels of ears.

In drying seed corn the ears should be spread on slat trays or shelves, or put on specially made drying racks, so that the ears will not touch each other. A serviceable rack is made by driving rows of long wire finishing nails, about 4 inches apart, on four sides of a stick 2 or 3 inches through, and sticking the butts of the ears over the heads of the nails. By numbering the nails on the stick the ears can easily be kept on record during the germination test. The rack should be hung up in any convenient place where the corn will not freeze till it is thoroughly air-dried. Another very good seed-corn rack may be made by taking No. 9 woven wire fencing with 6-inch stays and cutting the wires halfway between the stays. This leaves a core wire with stiff wire prongs sticking out on either side. Stick a seed ear on each of the prongs and bend one end of the core wire into a hook or loop to hang it up by.

Just before planting time, germination tests should be made of each ear. Six kernels are usually tested in making single-ear tests for germination, taking two kernels from opposite sides of the ear near the tip, two from the middle, and two from the butt. Many

forms of germinating boxes are used which are satisfactory. The seed should be kept moist and at about room temperature, not above 90° F. or below 50° F.

A simple tester is shown in figure 5. This is a shallow wooden tray about 1½ inches deep inside. This tray is divided into small squares by a checkerboard lacing of twine across the top. These squares should be about 1½ inches on each side. The tray should be filled level full of loose sand, and in each square is planted the seeds to be tested from an individual ear. The sand should be well moistened when the seeds are first put in the tester, and the tester kept in a warm room. Sprinkle on enough water from day to day to keep the sand moist, and after six or seven days examine the sprouting seeds, and save for planting only those ears from which all the kernels gave strong sprouts.

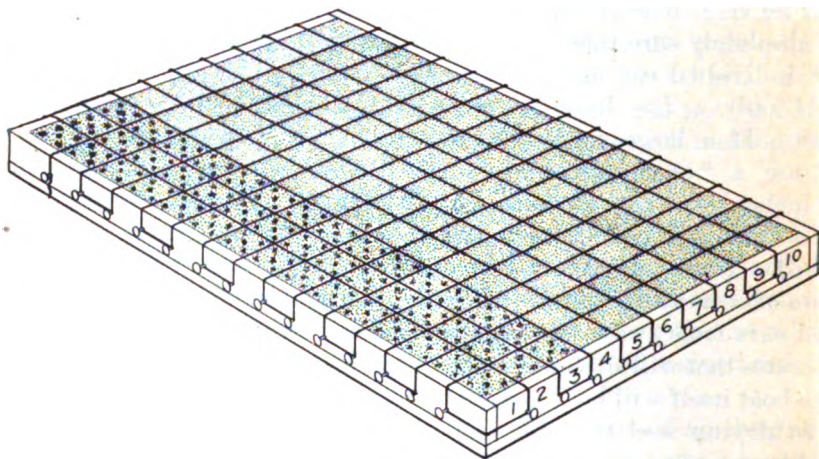


FIG. 5.—Sand tray for testing seed corn.

If seed corn is taken care of in this way, and every ear tested for germination, the result will be the best stand it is possible to obtain under weather and soil conditions at the time of planting. (For fuller details about testing seed corn, see Farmers' Bulletins 253 and 415.)

CLEANING SEED GRAIN.

Small-grain seed should be carefully screened and graded before sowing. This work is ordinarily done with the fanning mill, the lighter kernels and the trash being blown out by a current of air, while the small, shriveled kernels and most of the weed seeds are removed by screens. The proportion of the seed that is removed in cleaning varies largely with the quality of the seed grain. If the grain is plump, heavy, and fairly free from weed seeds, the

removal of about one-tenth of the entire quantity is usually sufficient, particularly with wheat and barley. In the cleaning of fairly good oats and of the poorer qualities of wheat and barley, about one-fourth of the seed should be removed. With very poor oats it is sometimes profitable to remove by cleaning as much as one-half the seed. The screenings are nearly as good for feed as the cleaned grain.

Cleaning and grading removes the small, light or shriveled kernels which will not germinate at all, or if they germinate, will produce weak plants. The removal of these kernels and the sowing of only good, plump seed helps to insure a uniform stand of vigorous plants and increase the yield. Screening also greatly reduces the quantity of weed seed which is sown, thus helping to prevent the spread of weeds and favoring the growth of the grain crop. Except with very poor seed it is usually not profitable to run it through the fanning mill more than once. However, light, trashy seed may need to be fanned twice to obtain seed that is good enough to sow.

All small grain is likely to "heat" when kept in the bin, and as heating may prevent germination, seed grain should be always carefully tested. Dig down a little way into the grain in the bin, take out a handful and put a hundred grains in the seed tester shown in figure 5, or between two sheets of damp blotting paper. Keeping the grains damp and warm for a few days will tell the tale.

Unless 85 or 90 per cent of the seed tested sprout you should increase the amount of seed sown or get better seed.

TREATMENT FOR SMUT.

To prevent stinking smut in wheat, stem smut of rye, and smut in oats and barley, first run the seed grain through a fanning mill to blow out smut balls and fragments of smut masses. Then treat with a solution of formaldehyde (1 pound, or pint, of the commercial "formalin" in 40 gallons of water) or of copper sulphate, also called bluestone (1 pound in 8 gallons of water). This may be done by placing the grain loosely in coarse bags and immersing, or by sprinkling the grain, shoveling it over while so doing, so that every kernel will be wet, and then allowing it to stand in a covered pile for a few hours. After treating, the grain should be spread out and dried as rapidly as possible.

In the method by immersion the period of treatment with formaldehyde for wheat should be not over half an hour; for oats, 2 hours; and for barley, 2 to 3 hours. With copper sulphate, for wheat, oats, and barley, the period should be from 10 to 20 minutes.

Corn smut can not be prevented. Treating the seed is useless and spraying the plants is at least not practicable nor entirely effective. With intensive culture, as with sweet corn, removal and burning of smutted plants may be partly effective. Continuous cropping to

corn contributes to smut losses. (For fuller details and hot-water methods of seed treatment, see Farmers' Bulletin 507.)

Precautions.—No treatment will be effective if all the grain is not thoroughly wetted. Smutty sacks or machinery used with treated seed will contaminate it again. Sacks should be thoroughly soaked in the treating solution.

Wheat from which the smut balls have not been entirely removed should be treated in an open tub so that they may be floated off by stirring and skimming.

Smut will not be entirely prevented in barley by the sprinkling process. By the immersion process other serious barley diseases will also be controlled.

Do not allow the grain to freeze while damp. If the grain is not thoroughly dry when seeded the drill or seeder must be set for a greater rate. The change needed can be determined by measuring the seed before treating and again when ready for seeding.

Copper sulphate (bluestone or blue vitriol) is more likely to injure germination than formaldehyde, particularly if the seed has been scratched or cracked in thrashing. Dipping the seed in milk of lime (1 pound slaked lime to 10 gallons of water) after treatment will sometimes prevent this. If copper sulphate is used the operator should avoid the use of metal vessels.

ALFALFA AND CLOVER SEED.

If you buy a bushel of clover or alfalfa seed for \$8 and only 50 per cent of the seed grow, your seed is more expensive than seed at \$14 per bushel which gives a test of 98 per cent live seed. If part of the 50 per cent that grow turn out to be weeds, you are worse off still. Buying seed is a business proposition, not an exercise of faith. No farmer who buys his seed "sight unseen," no matter how well he knows his dealer, deserves much sympathy if he fails to get a good stand. It is advisable to write to your State experiment station for information as to the best variety of alfalfa seed to use.

Always buy seed by sample. Tell your dealer that you will buy so many bushels of such and such seed subject to test. Get a handful of seed from a well-mixed bag and ask the dealer to set the bag aside, subject to your order. Buy several sheets of blotting paper and a 50-cent magnifying glass. A hundred sample seeds passed under the little microscope while you count the weed seeds out one by one will give you the exact percentage of impurity when the count is done. The remaining seeds placed between two wet sheets of blotting paper and kept damp and warm for a few days will tell the tale of living seeds. The sum of the seeds that do not sprout and the weed seeds will give you the percentage of bad seeds in the lot tested. If the sum

is 15, you must either look for better seed or sow about 15 per cent more seed to get the stand you want. *Let your dealer know that you test all the seed you buy.*

In alfalfa and clover seed there is always a certain percentage of seeds that, though good, will not germinate readily because of their hard shells. A way of cracking these shells by running the seed through a swiftly revolving machine has been developed at the Iowa Agricultural College. This process materially increases the percentage of germination in the hard-shelled strains of seeds. (For fuller details about treatment of hard-shelled legumes, see Iowa Press Bulletin 36 and Farmers' Bulletin 676.)

GRASS SEED.

The sprouting test for clover will serve for grass seed of all kinds, but the average farmer who hasn't made a careful study of these seeds can't tell much about the purity of a lot of grass seed. It takes an expert to tell one from another by sight. If you have time to wait for an analysis, and your dealer will hold a lot of seed subject to analysis, you can send a sample of seed to your State experiment station or to one of the seed laboratories of the United States Department of Agriculture and buy on the basis of the analysis you get.¹ Otherwise the best you can do is to buy from the most trustworthy dealer you know.

In this connection the study of seeds in country schools is to be recommended. The analysis and testing of seeds by school children could profitably be made a regular feature of school work.

SOME COMMON PESTS.

The chinch bug is black, with white wings. It winters in dead grass, piles of dead leaves and the like. Burning such rubbish during fall or early winter, especially along fence rows and in other places where the plow does not go, will kill a great many of the bugs. In early summer chinch bugs work first in the wheat fields, migrating to the corn fields when the wheat is cut. They may be killed most easily while thus moving from one field to another, since they do not fly readily at this time, and may be checked by a barrier of some kind and killed after they have assembled along the barrier. The best barrier is a line of road oil, No. 7, run along a narrow strip of earth hoed bare between the migrating bugs and the corn fields. Post holes dug at intervals along this line of oil will

¹ The Federal seed-testing laboratories that are most available for corn-belt farmers are:

1. Seed Laboratory, United States Department of Agriculture, Washington, D. C.
2. Seed Laboratory, Purdue University, La Fayette, Ind.
3. Seed Laboratory, Agricultural Experiment Station, Columbia, Mo.

serve as traps to catch the bugs as they trail up and down the barrier. They may easily be killed wholesale as they gather in the post holes. When the weather is very dry a dust mulch made by dragging a log up and down a plowed strip will check the bugs, but a sprinkle of rain will make such a barrier useless. (For fuller details about the chinch bug, see Farmers' Bulletin 657.)

The Hessian fly looks like a little mosquito. The damage is done by the maggot, which as it grows becomes embedded in the wheat stalk. The fly can not be destroyed in the growing wheat, either in fall or spring. One way to fight the fly is by burning stubble, when that can be done without hurting other crops. Another way is to plow under the stubble deeply as soon as the crop is off. Still another way is to sow wheat as late as possible, so that the young plants will not be above ground at the time when the flies are laying their eggs. When the Hessian fly is prevalent all volunteer wheat should be plowed down. Rotation of crops helps to keep the fly in check. (For fuller details about the Hessian fly, see Farmers' Bulletin 640.)

The army worm may be killed by the use of a poisoned-bran bait, made of a pound of Paris green mixed with 20 pounds of wheat bran. Dampen the mixture with water that has been sweetened with sirup—the refuse sirup from sugar mills is best—at the rate of 2 quarts of sirup to 3 gallons of water and add the juice of half a dozen oranges or lemons. The mixture should be well dampened to a dough, but not enough to render it mushy. Sow the bran broadcast where the worms are feeding. The army worms may be checked when “marching” from one field to another by scattering this mixture in front of them. The bran bait will be eaten greedily while damp, but hardly at all when dry. It is therefore important that the bait be scattered in the evening, or better yet at early daylight.

Cutworms may also be killed by the use of the bran bait. Scatter it about the hills of corn.

The corn-root aphid is perhaps the worst insect pest of the corn-belt cornfield. The aphid lives almost entirely upon the roots of the young corn, being carried from place to place by the common field ants, which keep and herd the aphid as a sort of domestic animal for the “honeydew” it secretes. The eggs of the aphid are kept over winter in the nests of the ants. Rotation is the best means of fighting the aphid, as it does not feed on small grain or legumes. However, if an infested field must be planted to corn a second year, the aphid may be checked by deep plowing and disking during very late fall or winter. This breaks up many of the ants' nests, destroying both ants and aphid eggs.

LIVE STOCK AS A "SIDE LINE."

The farmer who sticks to grain farming as his main product must keep more live stock than the average grain farmer keeps now. The only alternative is to grow large quantities of legumes and plow under good clover or soy-bean hay for manure—a thing that few farmers, on a show-down, have the nerve to do as a regular practice. It seems too much like plowing under money.

In order to get some idea of what effect keeping cattle on the farm has on the yields of grain and hay, the Iowa Beef Producers' Association in connection with the Iowa Agricultural College made a close study some years ago of 20 representative farms, 10 grain farms and 10 live-stock farms. The following are the average yields covering a five-year period.¹

		Grain farms.	Live- stock farms.
Hay, per acre.....	tons--	1½	2½
Corn, per acre.....	bushels--	38	52
Oats, per acre.....	do----	32	39

Such figures make a striking illustration of the well-established fact that where live stock is kept and the manure produced is returned to the land, the crops covering a series of years show a decided increase. There is no use trying to dodge the issue; even grain farmers should work more live stock into their scheme of farming.

Here we run into a snag. We can't afford to grow 7 and 8 cent cattle and 6 and 7 cent hogs and feed them entirely on 75-cent corn and other high-priced feeds. What are we going to do about it? Following are a few suggestions as to how the corn-belt grain farmer may get around this problem by growing and feeding enough live stock as a side line to utilize his waste.

Much of the growth of live stock should be made on roughage and cheap pasture. There is an immense amount of feeding material on corn-belt farms which can be sold off the farm at a profit only when fed to live stock. It is largely on this material that the profitable corn-belt live-stock production of the future must be based. Cornstalks, when possible, should be fed as silage or as fodder, and straw must be saved and fed, instead of being allowed to rot in the stack. However, to be of any great benefit as feed, both cornstalks and straw should be fed in connection with some concentrate. In addition to permanent pastures, valuable pasturage can be secured from clover, fall-sown rye, rape, or soy beans sown in the corn or on stubble land. The full corn ration must be held back until the animals are ready to be finished off. By utilizing forage crops and

¹ Proceedings of the Iowa Beef Producers' Association.

pastures in this way in the warmer months and feeding silage and straw in winter, a smaller amount of grain will be needed, and what is fed will be far more efficient in the ration—the animals will make much larger gains than when fed on grain without the succulent ration.

The practice of English and Scotch feeders gives us a valuable lesson in this regard. Their cattle are fattened largely on roughage and roots. In Scotland as much as 15 pounds of straw and 100 pounds of roots are fed daily to steers. In such a ration not more than 7 or 8 pounds of grain will be fed, and of this not more than 3 pounds daily is corn. As much or more cottonseed meal and linseed meal is fed. Usually Scotch farmers depend more on the latter feeds to furnish the concentrates in the ration than on corn meal. They figure that when the manure is carefully saved at least one-third of the value of oil cake is returned to the land in plant food.

By feeding "cake" (linseed, cotton seed, and similar meals), the European farmer counterbalances the loss of plant food resulting from the sale of farm products. The corn-belt farmer should in the future make a larger use of these feeds, or better still grow his own concentrates in the form of alfalfa or soy beans. European farmers would not think of keeping their live stock without concentrates and they get a large part of what they use from the United States. The United States exported in 1911 over 400,000 tons of cottonseed meal, in 1912 over 600,000 tons, and in 1913 over 550,000 tons. The manure made from this feed is worth fully half the original value of the feed itself. In fact, the fertilizing value of manure produced from oil meals is about four times that of manure made from corn.

The problem of keeping live stock with profit is largely a matter of making use of stuff that is wasted on the average farm. Wheat straw, for instance, usually rots in the stack or is used for bedding, yet it may very profitably be used as part of a regular ration. Cattle fed on silage seem to crave dry matter and will eat daily 3 or 4 pounds of wheat straw per head. Idle horses fed $1\frac{1}{2}$ pounds of oil meal and 8 pounds of corn per head each day will readily eat straw for roughness. There are no reliable statistics on the food value of straw, but here is one instance to the point:

On a farm near Sioux City, Iowa, 365 calves were each fed 18 pounds of silage, $1\frac{1}{2}$ pounds of cottonseed meal, 10 pounds of shelled corn, and 4 pounds of wheat straw daily, and showed a daily average gain of $1\frac{3}{8}$ pounds per head.¹

In wintering stock cattle large amounts of coarse roughage can be utilized to advantage if it is supplemented with some cottonseed meal or linseed-oil meal. Mature cattle can be wintered very eco-

¹ The department kept a complete record of this feeding operation, covering a year, and more detailed information may be secured by those interested.

nomically by giving them all of the straw and corn stover they will eat and about 2 pounds per head per day of one of these meals. If mature cows are given 5 or 6 pounds of clover or alfalfa hay in addition to corn stover or straw, they can be wintered cheaply and will usually pass through the winter in good condition; however, this ration can be improved by adding a pound of cottonseed or linseed meal. Mature cows have also been wintered economically on a daily ration of 25 pounds of corn silage, 1 pound of cottonseed meal or oil meal, and a few pounds of straw or stover. There is no other concentrate available for cattle feeding that surpasses these high-protein meals for supplementing farm-grown roughage.

It is usually assumed that for mature beef cattle 1 pound of cottonseed meal or linseed meal is equal in feeding value to 2 pounds of corn.

The hardest month on live stock in the corn belt is April. On many a farm, cattle that have been wintered fairly well are allowed to go through April on wind and water with the additional privilege of running to a straw pile. The use of this straw earlier in the winter as *part* of a balanced ration would make the farmers' limited supply of silage and concentrates go farther and the herd could frequently be carried through to May grass in good condition. It must be remembered that all the winter loss in weight must be made up before the summer gain can begin, and that if half the summer is wasted in making up that loss, profits will be largely reduced.

Weeds and weed seeds, usually counted worse than nothing, may be put on the right side of the ledger by means of a few sheep. A small flock of sheep will thrive on the weediest pasture and it has been shown that sheep make almost as good gains when fed on poor wheat or weed seeds¹ as when fed on corn. See the following table from Minnesota Station Report for 1893:

Cull wheat and weed seeds compared with cracked corn for fattening lambs.

Average ration.	Average daily gain.	Feed for 100 pounds grain.	
		Grain.	Hay.
	Pounds.	Pounds.	Pounds.
Lot I:			
Cracked corn, 1.3 pounds.....			
Timothy hay, 1 pound.....	0.25	523	402
Lot II:			
Small wheat, 1.8 pounds.....			
Timothy hay, 0.9 pound.....	.24	745	367
Lot III:			
Pigeon-grass seed, 2.4 pounds.....			
Timothy hay, 0.5 pound.....	.27	874	189
Lot IV:			
Wild buckwheat, 2.3 pounds.....			
Timothy hay, 0.7 pound.....	.28	816	249

¹ There is always the possibility of scattering weed seed in the manure from these lambs.

Thus you see that small wheat, pigeon-grass seed, and wild buck-wheat, materials that sometimes can be bought from elevators at low prices, produce good gains when fed to sheep in somewhat larger quantities than are required to get the same results with corn. When the price of weed seed is low the difference in price will make the low-grade stuff more profitable sheep feed than corn.

It takes good fencing to make the best of the waste on a farm. It costs about \$300 to make the fences on a 160-acre farm "hog and sheep tight," but the saving in waste material and waste labor will soon pay big dividends on such an investment. Figuring on an interest basis, even at as high a rate as 8 per cent, the interest would be only \$24 per year, and anything gained through good fencing over depreciation and interest on \$300 would be clear profit. With good management fencing can be made to pay for itself in a little time.

Every farmer who keeps any cattle should keep at least a few hogs to clean up after the cattle. A small herd of hogs will thrive thus on what would otherwise be sheer waste—the bits of undigested corn, etc., in the manure. Such a bunch of hogs frequently nets a profit that is almost clear "velvet," and that goes far toward justifying any expense put into hog-tight fences.

Another way to get dividends on good fences is to hog down your crops. By sowing 3 pounds per acre of dwarf Essex rape in your corn before the last cultivation an enormous amount of extra feed can be produced with little labor. The rape can be sowed quickly by riding a horse down every third row and sowing broadcast. Once such a crop of feed has been grown the hogs do the rest. On a farm in western Iowa 250 hogs, after having been fed a little new corn to get them accustomed to it, were turned on 160 acres to graze over the alfalfa meadow, rape, and pumpkin, and to hog down 40 acres of corn. They cleaned up all the scraps of corn and fodder that the men left on the ground when the silo was filled, harvested the rape and pumpkins, cropped the alfalfa close, husked the 40 acres of corn, and more than doubled in weight. There was absolutely no waste and no labor bill. That was producing pork economically.

On a farm in northwestern Iowa \$50 worth of Essex rape seed was sown after the last cultivation in 60 acres of corn and on 40 acres of oat stubble. After the corn had been husked 160 head of yearling steers were kept for 70 days on the cornstalks and rape, with daily feeds of straw, corn, and cottonseed meal. They were turned into the 100 acres each morning, driven out at 5 p. m., and fed per head 8 pounds of corn, 2 pounds of cottonseed meal, and between 3 and 4 pounds of oat straw. After taking out the cost of the corn and meal there was a profit of \$600 from the waste in the 100 acres, and in addition a large amount of feed was furnished for the hogs following the cattle, the entire farm being fenced hog tight.

The common custom of turning cattle in to clean up cornstalks is unprofitable, unless other feeds are added. If you feed a little alfalfa hay and two pounds of flax or cottonseed meal per head daily with your cornstalks, you make those cornstalks worth money to you. If you are afraid or unable to spend a little money for feed to balance the ration, your cornstalks merely go to keep your cattle alive, instead of to make beef. (For fuller details about cattle feeding, see Farmers' Bulletin 588.)

The silo is another money saver. It saves practically all of the 40 per cent of the corn crop that is wasted when you simply husk the corn and leave the stalks. Silos, however, cost money, and the machinery for handling silage is expensive. It is well for the average farmer before he builds a silo to plan carefully and make sure as to what size silo he needs. In order to keep the silage fresh all the time while feeding, a thin layer of about 2 inches should be fed off the entire top each day, and if the silo is so large that this can not be done, some of the silage will mold and become worthless. A silo 12 feet in diameter is a very convenient size to use when the farmer plans to keep from 12 to 18 cows. He should also count the cost well and be sure that the profits promise to justify the investment. Silage is a feed of the greatest value, especially for dairymen, but it does not follow that every farmer needs a silo. (See Farmers' Bulletin 578 for fuller information about silage.)

The time of marketing may have a good deal to do with securing a profit on cattle-feeding operations. As a rule the market is highest for well-finished fat cattle during the summer months, and the feeding operations should be arranged to finish the cattle for market some time during this period. Most feeders buy their cattle in the fall, feed a few months, and then sell during the winter, often when the price is below the cost of production, usually getting little or nothing for the feed consumed. As a general rule the feeder should hold his cattle when everyone else is selling, and sell when there is a strong demand and prices are good.

The sex of the horses you keep may have a good deal to do with the amount of your total returns from live stock. If you keep mares rather than geldings and breed them to foal each year, the colts you raise become a valuable by-product of your farming operations. If the barn has warm box stalls the mare may well be bred to drop her colt late in the fall after the heavy work is over, or early in the spring before the heavy work begins. Ordinarily, however, it is best to breed so that the foal will be dropped in May or early June when the mare and colt can run on grass, but still early enough so that the colt will be weaned before cold weather begins in the fall. Fall colts are a paying proposition if properly handled, but unless the

farmer can provide good warm quarters, and is willing to give special attention to the care and feeding of the young colt and its mother, his best plan is to have his colts foaled in the spring. Any well-bred colt is worth more than enough at weaning time to pay the cost of keeping the mare through the entire year. (For fuller details about colts, see Farmers' Bulletins 619 and 667.)

A great saving in the labor involved in handling live stock can be made by feeding once a day. Many of the best cattle feeders in the West now follow this plan. If the cattle are fed the daily allowance of hay in the morning and the daily allowance of corn an hour afterwards, one man can easily take care of 250 cattle. By feeding the hay first you get around the danger of the greedy steers getting too much corn. It has been demonstrated that there is little or no difference in results between feeding once a day and feeding the same feed in two portions, but there is a marked difference in the cost of the labor involved.

When cattle or hogs are on full feed, one of the best ways of fattening is by the use of the self-feeder. By this system all the feeds are kept before the stock all the time and it is possible for the animals to get more nearly a naturally balanced ration. The self-feeder is so made that there is no loss of feed, and the time required for filling it and keeping it clean is much less than that consumed in hand feeding. At the Iowa Experiment Station it has been demonstrated that hogs will gain faster, and at less expense, by the use of the self-feeder than when hand fed.

SAVING MANURE.

The success of the system above outlined hangs on one very important condition—the manure must be saved.¹ If you break even on your beeves you are ahead of the game provided you save your manure, especially if you have kept hogs following the cattle. To the corn-belt farmer who keeps live stock as a side line, for the purpose of building up his soil, the manure represents a large percentage of the profit, often the entire profit. If you allow these profits to be wasted, then the safest thing to do is to leave live stock alone.

“Saving manure” in this sense doesn't mean saving merely the one-fourth or one-third of the manure produced that is saved on the average farm. It means saving 70 per cent or more, liquid as well as solid.

¹ How important a factor in farm life this is may be seen from the fact that the value of farm manure in the United States, if all the manure was properly saved, would be greater than that of the combined mineral and timber output of all our mines and forests. If properly saved, the value of the manure produced annually would be \$2,225,700,000. At least half of this is lost through carelessness, making an annual loss to the American farmers of \$1,112,850,000. (See Farmers' Bulletin 192, p. 5.)

If the manure can be hauled to the fields as fast as it is made, that is the cheapest and most effective way to handle it; if not, it may be stored in concrete pits. Cattle and hogs not fed on pasture should have paved feed lots and the lots should be kept heavily bedded with straw. The saving in the manure and in the increased gains of the animals will soon pay for the concrete work.

If a farmer can not afford a concrete manure pit or a paved feed lot, he can save a large percentage of his manure, both liquid and solid, by feeding under a cheap open shed and bedding heavily. If the feed racks are made so that they can be raised from time to time, it is possible to feed under such a shed till from four to six feet of solidly packed manure has collected. Experience has shown that there is very little heating in manure kept in this way, and that little of the manure is lost by leaching, since the shed keeps the rain off. The practice of allowing the manure to accumulate under the feet of the cattle in such a shed is very common in France.

On days when the ground is dry or frozen it is generally advisable to feed the cattle their roughage in the fields. Thus the manure produced during the day will be left on the ground, to be plowed under in the spring.

When it is realized that a 1,200-pound steer produces 70 pounds of manure per day, liquid and solid, and that perhaps two-thirds of that is lost if the animal is kept in an open feed yard, it is easy to see the advantage of feeding cattle under a shed or in the fields when possible, since it means a saving of about 50 pounds of manure per animal per day—7 tons a year.

When once fitted into the farm plan, live stock should be kept there. Look around you and you will notice that usually the really substantial farmers in your neighborhood are those who have made live stock an integral part of their business and who have stuck to it.

Finally, your live stock should be well bred. The females need not be pure bred, but the bulls and boars should be pure bred in every case. In buying a registered animal two things must be observed particularly: First, the animal must be a good individual. No pedigree certificate can make a poor bull a good one, and the breeding value of the animal comes from the "blood in his veins," not from the typography of his pedigree certificate. Second, he must be a sure breeder.

Any one of a number of breeds will give good results. The best general rule to follow in this respect for the corn-belt farmer is to select the breed which is most popular in the community in which he lives and stick to that unless there is some very good reason for changing to another breed.

SIDE ISSUES.

Utilizing waste time.—The problem of waste time is a serious one on most farms. Rainy weather means losing the farmer's time and that of his hired men, while during the winter and other slack seasons this loss is even heavier. Every farmer should have a list prepared in advance of profitable ways to employ waste time.

Preparedness is as important for the farmer as it is for the soldier. The farmer who wins is the farmer who keeps up with or ahead of the game, who utilizes rainy days and slack seasons to get his affairs in such shape as to enable him to meet the demands of his busy seasons without strain or confusion.

For example, when it is too showery or too muddy to work to advantage in the fields, weeds can be mowed with a mower or scythe; fences can be repaired or built; tools can be overhauled, repaired, or sharpened; buildings can be repaired, hedges can be trimmed or pulled out; bushes can be grubbed from meadows and pastures or along fence rows. The farm garden often can be worked when the weather will not permit field work, and stock farmers frequently can haul hay and straw from the field between showers.

Even the winter season can be made highly profitable if intelligently employed. Stock farmers have a supply of regular work during that season, but they and all other farmers should recognize the possibilities of the winter months as a season of preparation for the rush of work in the spring.

Manure should be hauled out in the winter whenever the weather permits. Farm machinery should be greased or oiled when put away and then carefully gone over during the winter months and thoroughly repaired. Edged tools should be sharpened, harness repaired and greased, extra whipple trees made, and buildings repaired. Fence posts can be cut, and firewood for the year laid in and chopped ready for use. During the winter months needed wells or cisterns should be dug, seed corn should be tested, and small grains should be cleaned and tested.

Moreover, every farmer should lay out for himself, or get the County Agent or the State Agricultural College to lay out for him a course of reading from agricultural bulletins for the winter months.

Every farmer should try to acquire each winter a thorough knowledge of some new crop, or of some new scientific agricultural method. One winter alfalfa could be taken up, the next soy beans, the next pigs, etc. In addition to this, when possible, the farmer should attend, or send his boys to the short course at the State Agricultural College.

Moreover, every farmer would do well during some slack season to visit his nearest terminal market for grain and live stock, in order to study conditions and talk with the officials of the live-stock and grain exchanges, with commission merchants, bankers, and State and Fed-

eral officials. In no other way can he acquire a detailed, first-hand knowledge of market conditions.

In these and in various other ways during the winter months a farmer can prepare himself for successful and profitable farm operations during the rest of the year. The farmer who wastes his leisure time, instead of utilizing it to the utmost advantage, can never hope to catch up by hard work during the busy seasons, for every successful farmer works as hard as he can during those seasons anyhow.

Size of farm.—There is a widespread opinion to the effect that the average American farm is too large. The examples of small, intensively cultivated European farms are cited as arguments in favor of cutting down the acreage of the average American farm. Exhaustive studies of farm operations by the Office of Farm Management have demonstrated, however, that in the corn belt farms under 200 acres are less profitable than those of from 200 to 240 acres.

This is true for several reasons. A farm of 160 acres devoted to standard crops in one of the usual corn-belt rotations is too large for one man and not large enough for two, and it is much more difficult to get good, temporary hired men than it is to get good, permanent hired men. Moreover, a farm under 200 acres does not get the maximum service out of a set of farm implements or out of its necessary quota of work horses. Furthermore, as most farmers have discovered, it is not possible to work out as satisfactorily a rotation of standard crops on 160 acres as it is on 200 or 240 acres.

For these and other reasons it will prove to the advantage of both landlord and tenant in the corn belt, wherever possible, to have the land divided into farms of from 200 to 240 acres.

Keep accounts.—No farm can be run on a business basis unless the farmer keeps track of receipts and expenditures and balances his accounts at least once a year. It doesn't require complicated book-keeping to do this. A simple system of accounts that any schoolboy can keep will serve the purpose very well. The problem is to find out just where your money comes from and just where it goes. Once that is determined, it is easy to put your finger on the strength or weakness of your system of farming. (Write to the Office of Farm Management, U. S. Department of Agriculture, for information regarding farm accounting, or send for Farmers' Bulletin 511.)

The kitchen garden.—Dr. T. N. Carver, of Harvard, has said that the worst thing about the average farmer's business system is that he "sells everything wholesale and buys everything retail." As long as the average farmer "keeps his garden on the grocery shelf," and eats peas and string beans out of tin cans, this criticism of his business method will hold good.

Many farmers nowadays seem to feel that it is beneath their dignity to bother with a garden. They wouldn't feel that way if they could

realize that side issues like a garden, a few chickens, milch cows, pigs, a few ewes, and a few colonies of bees—things that turn waste material and odds and ends of time into money—often make up the difference between loss and profit in the operation of a farm.

A well-kept half-acre garden will pay twice as much as any other half acre on the place. If you haven't such a garden it's time you fenced off the richest and best-drained half acre on the place and went into kitchen gardening as a serious undertaking, for you are violating one of the first principles of independent farming as long as you don't supply your own table with all the staple vegetables you need. (For fuller details about farm gardens, see Farmers' Bulletins 154 and 255.)

A smokehouse (which may be merely a barrel or a big store box set over a crude trench furnace) is another side issue that can be run with profit on any farm where hogs are raised. "Smoked ham" that really hasn't been smoked at all retails for something like 20 cents per pound, and bacon costs even more. The difference between the prices of ham, bacon, lard, etc., and the price of hogs on the hoof gives an idea of what you stand to gain by butchering your own hogs and smoking the hams and bacon at home. There is generally a good sale for any extra home-cured meats or rendered lard of high quality that the farmer may have to sell. (See Farmers' Bulletin 183 on home-cured meats.)

A small flock of chickens can be kept on the average farm with almost no outlay, since a reasonable number of chickens will thrive on what would otherwise be wasted. The return from such a flock, in the way of meat and eggs, is almost clear "velvet." (See Farmers' Bulletins 287 and 528 on poultry.)

There are still other side lines that may be mentioned in this connection, such as drying sweet corn, putting up sauerkraut, canning tomatoes and small fruits, making apple butter and other fruit butters, and storing or burying potatoes, beets, carrots, and other root crops for winter use—all practices that seem to be falling into disuse now, but all profitable to the farmer who is wise enough to include them in his farming scheme, and to see that the women of his household get all necessary help with this work. (For fuller details about canning vegetables, see Farmers' Bulletins 203 and 521.)

The farm home.—If the boys and girls are to be kept on the farm—the farm must be made not only a financial and economic success, but also a family and civic success. A truly successful farm must be vastly more than a workshop. It must be not only a place on which to make a living, but also a place to live on, a vital part of a rural community, of the State, and of the Nation. Moreover, financial success is important chiefly as a foundation for a home and a civic superstructure. After all, only that wealth which can be

translated into terms of life is really possessed by its owner. There are farmers with big farms, big herds, and big bank accounts, who seem to have no knack at utilizing their financial success for family happiness and welfare. It is not always the wealthiest farmer who has the most attractive front yard, orchard, and garden, or the coziest and most comfortable house. Some men's wealth is like a good deal of the fertility in their soil—it is "not available."

It does not necessarily cost much to make a farm homestead trim and green and the house sanitary and attractive. Most European farmers and many Eastern farmers, though their incomes average less than those of our farmers of the Middle West, take more pains to beautify their home surroundings than we do in the corn belt. No investment of time or money pays as large a return, dollar for dollar, as does the comparatively small amount spent on transforming the average farm house and yard into an attractive country home.

Moreover, when a farmer makes his home attractive and adds a garden that will supply the family needs, he has taken a long step toward making the farm a commercial and economic success. A farm house and garden may be considered as constituting the hub of the wheel to which the other factors of the farm are the spokes. You can't have much of a wheel without a sound and satisfactory hub. Any reasonable expenditure for making the home place more attractive is as real and profitable an investment as though the money had been spent for limestone or phosphate.

HORSE SENSE.

Legumes, lime, live stock, saving of waste, business methods, horse sense—these are the essentials for the highest success in corn-belt farming, and the greatest of these is horse sense, for in a way, it includes all the others.

Without horse sense there's a poor show for making a real money success of farming of any kind. Without that faculty, otherwise called "business ability," industry, capital, credit, and even a thorough knowledge of the most approved scientific methods of agriculture all will be of little avail. To qualify as a business farmer, a man must have that peculiar sort of "gumption" which enables him to shape his work and change his plans according to changing weather, shifting markets, and up-and-down business conditions. He must be able to decide whether he can best dispose of his crop by feeding, or by selling on the market. In selling either live stock or grain, the farmer should know enough of the actual value of his product to know when the local buyers are offering him a fair price. To know the actual value of his product he must know the freight rates to market, what commissions, insurance, and other expenses

must be met, as well as probable shrinkage, etc.; but these are facts that any farmer can easily secure.

It is not enough to grow a good crop, or even to grow a good crop at low cost. To make the big crop a business success it must be disposed of as efficiently as it is grown—must be so graded and packed as to meet market standards and so marketed as to bring the farmer the highest current prices.

Moreover, the farmer who is too suspicious to get together with his neighbors in order to do cooperatively what no one can do alone is sure to pay dearly for his lack of confidence and his incapacity for teamwork. The social spirit and a capacity for cooperative effort are fundamental necessities of the new agriculture. The day of the Ishmaelite and the individualist is over. The future belongs to the men who are able to cooperate with their fellows in pursuit of their common interests.

The farmer who sells all his crops at the elevator is robbing his own soil, his own purse, and his own children—selling their birthright for a mess of pottage. The farmer who not only does this, but also burns all his cornstalks and straw, reminds one of the burglar who takes all the valuables he can carry off and sets fire to what is left.

According to figures gathered recently by the Department of Agriculture, American farmers burn each year \$65,000,000 worth of straw. When we consider, in addition to the straw thus wasted, the vast quantity of cornstalks burned, worth, on an average, \$3 per acre for manure, and estimated to total in value fully as much as the straw burned, we begin to get some idea of the fertility that goes up in smoke on American farms each year. In exceptional cases it may be found advisable to burn straw and cornstalks. For instance, in order to get rid of insect pests, or in case there is no live stock to consume the straw, nor enough moisture to rot it if it is turned under. But it is safe to say that every year in the United States \$100,000,000 worth of straw and cornstalks are burned that could advantageously be used for feed or fertilizer.

A man who fails to make a success of farming because of his failure to apply recognized principles of successful agriculture, or because of his failure to conform to recognized business principles, has largely himself to blame. Success to-day can not be gained by slipshod or happy-go-lucky methods. Certain well-known methods produce certain highly desirable results. A man may get a good crop occasionally in spite of inefficient methods. But to get the best obtainable crops and the best obtainable prices for those crops year after year requires a working knowledge of the science of agriculture and of sound business practice.

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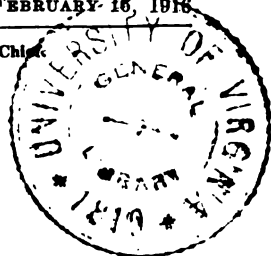
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FEBRUARY 16, 1916

Contribution from the Bureau of Entomology, L. O. Howard, Chief

THE CATALPA SPHINX.¹

By L. O. HOWARD and F. H. CHITTENDEN.



INTRODUCTION.

Our native species of catalpa, the common or eastern catalpa² and the hardy or western species,³ are comparatively free from insect attack. Such common shade-tree pests as the bagworm⁴ and fall webworm⁵ occasionally feed upon the leaves, but apparently do so only in the absence of food more palatable to them. There is one insect, however, the larva or caterpillar of the catalpa sphinx (fig. 1, *b, c, e, f, h*),¹ which feeds normally and exclusively on the foliage of these trees and in some seasons does very considerable injury, often completely stripping the leaves from individual trees and sometimes from an entire grove. (Fig. 2.) Owing doubtless to the increased planting of these trees outside the regions in which they are found in the wild state, this insect has extended its natural range, and its injury is more widespread now than formerly.

DESCRIPTION.

The catalpa sphinx in its active feeding stage is a caterpillar fully 3 inches in length. It is very variable in color, there being a light and a dark form, as in the case of some related species. The prevailing colors are yellow and black, and this, combined with the large size of the insect, makes it a conspicuous object on infested trees. The complete life history by stages or periods of growth is well illustrated in figure 1.

¹ *Ceratonia catalpae* Bdv.; order Lepidoptera, family Sphingidae. ² *Catalpa catalpa*.

³ *Catalpa speciosa*. ⁴ *Thyridopteryx ephemeraeformis* Haw. ⁵ *Hyphantria cunea* Dr.

NOTE.—This bulletin is of interest throughout the United States wherever catalpa trees occur.

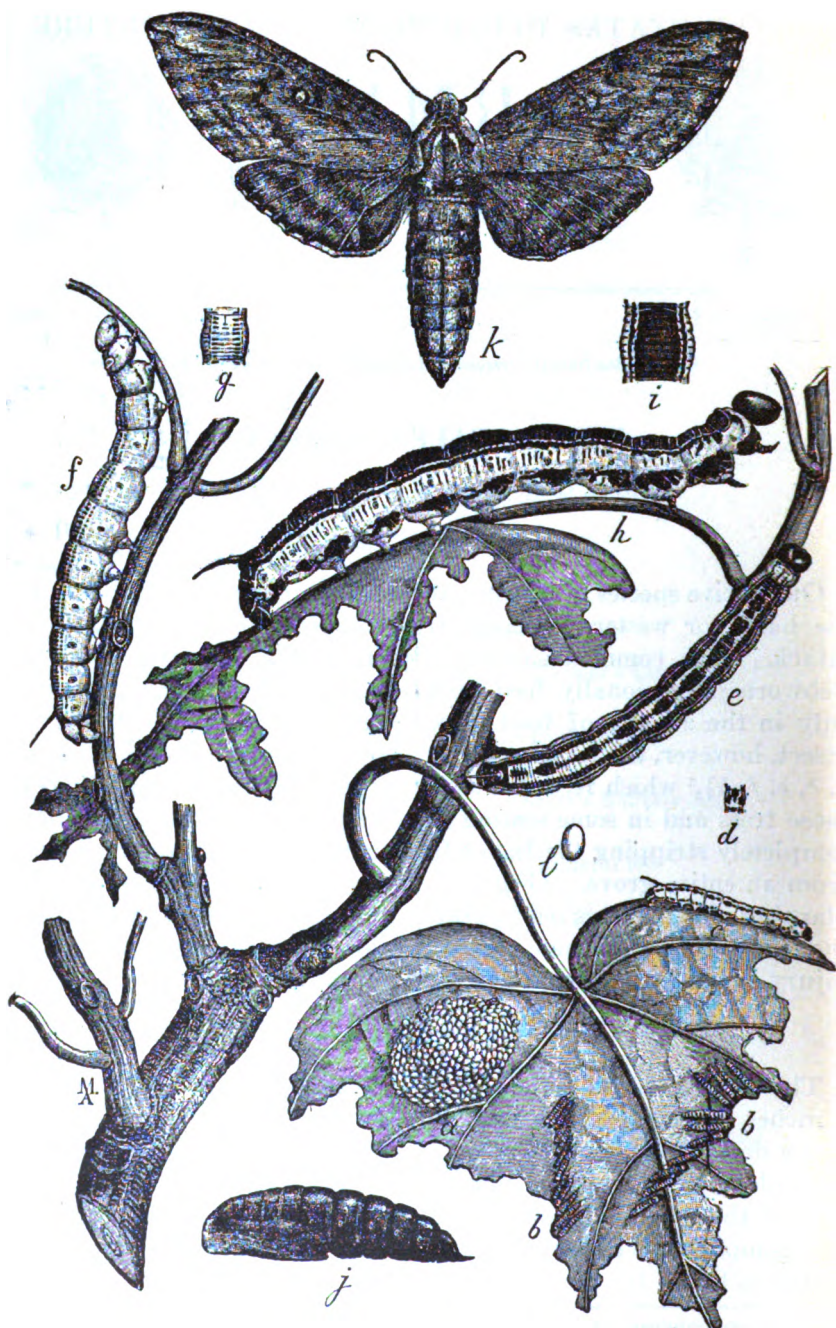


FIG. 1.—*Catalpa sphinx* (*Ceratomia catalpac*): a, Egg mass; b, b, newly hatched larvæ; c, larva one-third grown; d, dorsal view of joint of c; e, f, two differently marked, nearly full-grown larvæ; g, dorsal view of joint of f; h, full-grown dark larva; i, dorsal view of joint of same; j, pupa; k, moth; l, egg, enlarged. All natural size, except l. Marx del.

The parent of the caterpillar is a large grayish-brown hawk moth, marked as shown in figure 1, *k*. It has a large, heavy body and powerful wings which measure 3 inches from tip to tip when spread. It lays its eggs in masses, in which respect it differs from other hawk moths. An egg mass is shown in the illustration at *a* and an individual egg at *l*. The young caterpillars are lighter colored than the mature ones, being pale yellow. Two striking variations of the larva



FIG. 2.—Catalpa trees showing excessive defoliation by the catalpa sphinx. (Original.)

in the later stages are shown at *f* and *e*, while *h* represents the commonest dark form of caterpillar. The larvæ have a stout black horn near the hind end of the body.

ORIGINAL HOME AND PRESENT DISTRIBUTION.

The known distribution of the catalpa sphinx at the present time (1915) is shown in figure 3. This insect is strictly a North American

species, and its range was given in 1888 as from "Virginia to Florida: westward to the Mississippi; as far north as Indiana." It is common in Virginia, Maryland, and Ohio, and of late years it has extended its range northward on the Atlantic coast and has been received from several localities in southeastern Pennsylvania, New Jersey, Ohio,

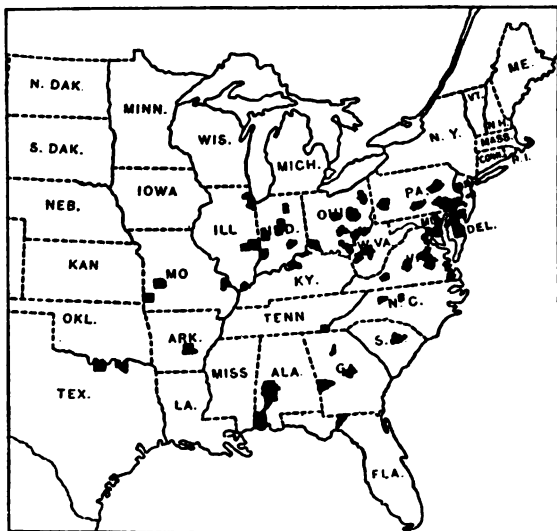


FIG. 8.—Map showing the known distribution of the catalpa sphinx in the United States in 1915. (Original.)

Kentucky, and Delaware. It has spread northward in Delaware and has greatly increased in numbers where it was formerly rare. Its northward range appears to be limited in the West by Illinois.¹ This species was observed in Alabama in 1883; was received from Denison, Tex., in 1889, and was reported from Arkansas in 1900. By 1906 it had become established at Elberon and

Bloomfield, N. J., the latter, westward and a little north of New York City, being the northernmost point of which we have knowledge of its occurrence in the East. It has since been reported from Burlington, N. C., Jericho Springs, Mo., and Wetmore, Tenn.

LIFE HISTORY AND HABITS.

The catalpa sphinx is subject to considerable fluctuation in numbers. For one, two, or even several years it will not be seen in a given locality and will then suddenly appear in large numbers, completely defoliating the trees and covering the ground beneath with larval excreta. It is interesting to observe that John Abbot, who collected the type specimens in Georgia, mentioned the fact more than a hundred years ago that fishermen who inhabited the borders of the swamps hunted for these larvæ as the best bait for catching fish, and

¹ The range of its food plants is as follows: From the Gulf of Mexico in western Florida, and on the rivers in Alabama and Georgia, westward and northward along the Mississippi and its southern tributaries in the great delta formation to above the mouth of the Ohio; thence up the Wabash and White rivers of Indiana to near Vincennes. This was formerly taken by entomologists to indicate also the range of the catalpa sphinx. Published records, however, were lacking until recently to show its general occurrence west of Florida and Georgia along the gulf.

it is said that this bait is so esteemed for this purpose in some parts of Florida that the catalpa is often cultivated for no other purpose than to attract the insect.

The eggs, as has been stated, are laid in masses, and the young larvæ feed in groups for some time. The capacity of the species for multiplying may be judged from the fact that an egg mass in the collection of the United States National Museum contains nearly 1,000 eggs. The mass is not compact, however, and is but slightly fastened to the underside of the leaves. Sometimes the eggs are laid in smaller masses on the stems and branches. The larvæ molt four times, becoming variable in their markings as they grow older. In the extreme South the insect is reported as being found in all stages during the summer, and there are three or four generations a year, the last generation wintering in the pupal stage beneath the ground and giving forth the moths the following March. In the summer, according to observations made in Florida, the time occupied by a complete generation is about six weeks. Around Washington, D. C., at Coalburg, W. Va., and probably everywhere in its southern range, there are two generations annually.

NATURAL ENEMIES.

A number of parasitic insects attack and kill the catalpa sphinx. *Apanteles congregatus* Say, a common, widespread, and very general parasite of sphinx caterpillars throughout the eastern United States, attacks this species quite as freely as it does the hornworms of tobacco and tomato. Unfortunately, this parasite is in turn attacked by other parasites, two species of which¹ are recorded. These last, fortunately, do not seem to be generally abundant, hence the beneficial parasite flourishes in spite of their attacks. *Apanteles congregatus* is a minute, four-winged, wasplike insect which lays its eggs in the sphinx caterpillar. Its larvæ—white, maggotlike creatures—develop within the body of the caterpillar, and when full fed and ready for transformation each individual eats a hole through the skin of the caterpillar and spins its little white cocoon on the outside. Two hundred or more such cocoons may be seen on the body of a single caterpillar. After a few days the winged parasites issue from the cocoons to lay eggs and produce another generation of larvæ.

(*Apanteles*) *Microplitis catalpæ* Riley, which appears to be especially a parasite of the genus to which the catalpa sphinx belongs, is also an enemy of this species, although, like the *Apanteles*, it is sometimes itself attacked by other parasites.²

¹ *Mesochorus aprilius* Ashm. and *Hemiteles mesochoridis* Riley MS.

² *Hypopteromalus tabacum* Fitch and (*Holcopelte*) *Horismenus microgastri* Ashm.

Two common species of tachina flies¹ attack the larva of the catalpa sphinx. These are general parasites of butterflies and moths, the former infesting 27 distinct species, the latter 22.

A few birds prey upon the caterpillar, but most of them evidently find it when full grown a rather tough morsel, the skin being especially thick and resistant and the insect a very muscular one, so that, in fact, it is difficult to crush one with the end of a cane. Among the

birds which have been recorded as destroying this insect are cuckoos, the cat-bird, and the Baltimore oriole.

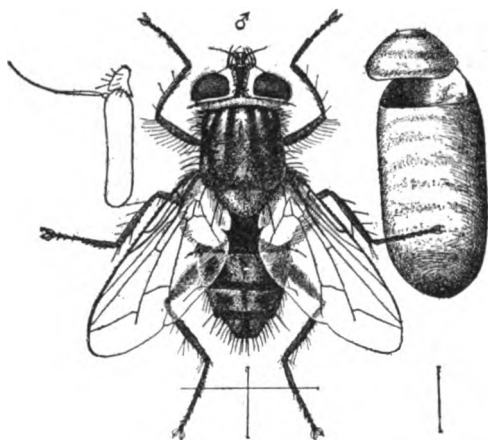


FIG. 4.—One of the tachina flies, *Phorocera claripennis*, a parasite of the catalpa sphinx: Adult with puparium at right and enlarged antenna at left. (From Howard.)

tree trunks in the fall, and, indirectly, the sphinx may be destroyed by protecting the parasitic insects which attack it.

REMEDIES.

There are several methods by which the catalpa sphinx may be readily destroyed. The caterpillars may be gathered by hand, the foliage of the trees may be sprayed with arsenical poisons, the pupæ may be destroyed by spading the ground around the

HAND PICKING.

Owing to its large size, the caterpillar is easily seen and can be controlled by hand picking. In the case of large trees a long ladder and a 12-foot pole pruner or similar device will be necessary in this work.

SPRAYING WITH ARSENICALS.

Where the caterpillars are injurious to trees of considerable height, rendering hand picking difficult, or where they occur in such abundance as to render probable the complete defoliation or stripping of the tree, the application of an arsenical spray is the best method for their control. Advantage may be taken of the gregarious habit of the young caterpillars by watching rather closely for their appearance in the spring, and if the leaves are observed to be eaten in any particular place, promptly applying an arsenical spray.

The arsenicals ordinarily used in the control of shade-tree insects are arsenate of lead and Paris green. If properly applied, neither of

¹ *Phorocera claripennis* Macq. (fig. 4) and *Frontina frenchii* Will.

these will be injurious to the leaves. In the preparation of these materials for spraying, the desired quantity of the chemical, usually 1 pound of Paris green or 3 pounds of arsenate of lead to 50 gallons of water, is weighed out and thoroughly mixed in a pail or other small container with a gallon or two of water. This mixture is then poured into a 50-gallon barrel, the remainder of the water added, and after having been strained through fine copper gauze for the removal of particles which might clog the nozzles, the spray is ready for use.

The application of the arsenate of lead or Paris green spray in combination with Bordeaux mixture is desirable, since the foliage of the catalpa is frequently infected by leaf spot¹ and by other similar diseases which may be controlled by the application of Bordeaux mixture. Moreover, in the presence of Bordeaux mixture no burning is likely to result, even to the most delicate foliage, through free arsenic in the Paris green or arsenate of lead used in the spray mixture. Bordeaux mixture may be prepared for this purpose as follows: In a barrel containing 25 gallons of water hang 6 pounds of blue vitriol or bluestone in a cloth sack. Four pounds of fresh stone lime should then be slaked in a pail or other container and water added until of about the consistency of whitewash. This mixture should then be poured into a second barrel with 25 gallons of water. In the usual preparation of spray mixtures 50-gallon barrels are used. After the bluestone has dissolved and the lime has been added to its respective quantity of water the two barrels may then be raised and simultaneously poured into a third one, the mixture being well stirred at the same time. After the preparation of the Bordeaux mixture according to this formula the requisite amount of Paris green or arsenate of lead is added and thoroughly stirred into the mixture.

A sprayer suitable for the control of the catalpa sphinx caterpillar, or other larvæ feeding on the leaves of catalpa or other trees of similar size and habit, might consist of one of the smaller power outfits such as are used in orchard spraying, or one of the large double-action hand pumps capable of furnishing a spray mixture to from three to five nozzles of the removable steel-disk type, using the large opening, at about 100 pounds pressure.

With the aid of a 10 to 12 foot tower on the wagon and an extension rod on the hose line, it will be possible to treat trees from 35 to 40 feet in height, which is about the maximum for the ordinary catalpa under cultivation. For trees of greater height a three-eighths to one-fourth inch nozzle of the Worthley type, supplied by a pump capable of delivering from 30 to 50 gallons a minute at a pressure of from 300 to 400 pounds, will be found necessary. Trees as much as 100 feet in

¹ *Phyllosticta catalpae*.

height have been sprayed in this manner from an ordinary sprayer tower. A high-power spraying outfit of the type used against the gipsy moth is shown in figure 5. Such a powerful stream will dis-



FIG. 5.—High-power spraying outfit for treating large caterpillars like the gipsy moth and catalpa sphinx. (From Burgess and Rogers.)

lodge many of the caterpillars. Particular attention is called to the upper end of the stream, in the illustration, where it breaks into a mistlike spray.

DESTRUCTION OF THE PUPÆ.

Where the caterpillars have been so abundant as to affect the trees, it will pay as a precaution for the following year to spade up the ground thoroughly and disintegrate it in the fall so as to destroy the pupæ, which will be found concentrated under the surface of the ground in the immediate vicinity of the trunk.

PROTECTING THE PARASITES.

The second or last generation, which appears in September and October, is largely destroyed by parasites which are frequently very abundant just as the oldest caterpillars are beginning to reach full growth. At this time the parasites, which have been previously mentioned, issue from the bodies of their host and spin large masses of white cocoons on the backs of the caterpillars. These masses are so large that they can be seen at a considerable distance against the black stripes of the host insect. It is not advisable to destroy the caterpillars at this stage, as the parasites are very beneficial and in ordinary seasons will reduce the numbers of the sphinx caterpillars so that they will not do much harm the following season. Where the caterpillars can be easily gathered it will pay to pick them from the leaves and transfer them to barrels or large boxes covered with wire netting. This will prevent the caterpillars from issuing or falling a prey to birds or other animals, and will insure the issuance of the parasites through the meshes, thus encouraging their good work. A few holes should be bored in the bottom of the barrels or boxes used, small enough to prevent the caterpillars from crawling through them into the ground. This will prevent the accumulation of water after rains, which might drown the insects or set up putrefaction in the mass.

COOPERATION.

If the cooperation of neighbors who have catalpa trees growing on their premises can be secured, this caterpillar can be largely controlled for several years in succession.

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Contribution from the Bureau of Biological Survey, Henry W. Henshaw, Chief.

LAWS RELATING TO FUR-BEARING ANIMALS, 1915.

A SUMMARY OF LAWS IN THE UNITED STATES AND CANADA RELATING TO TRAPPING, PROTECTION, PROPAGATION, AND BOUNTIES.

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INTRODUCTION.

In connection with its investigations concerning the propagation of fur animals, the Bureau of Biological Survey is constantly called upon to answer questions relating to fur bearers and trapping regulations in all parts of the country. The demand for such information has steadily increased from year to year, and it is now thought that the bureau can best serve the public by summarizing the State laws and regulations in the form of a bulletin. For 16 years the bureau has issued an annual summary of legislation relating to the taking of game.¹ The great and increasing demand for that bulletin indicates that the present venture may also find a wide field for usefulness. In this first publication only a brief summary of trapping regulations in the various States and Canadian Provinces is attempted, followed by short statements regarding open seasons, provisions relating to propagation of fur bearers, and bounties offered for the destruction of predatory animals. Bounties for other animals considered noxious are included, whether for quadrupeds, birds, or rattlesnakes.

The laws relating to deer and other big game, rabbits, and squirrels are not considered here, as they appear in the game law bulletin. Those relating to bears are included, mainly because of their interest in connection with bounties.

¹ Game laws for 1915. A summary of the provisions relating to seasons, export, sale, limits, and licenses. Farmers' Bulletin 692, Sept. 14, 1915

NOTE.—For general distribution among persons interested in fur farming, trapping, and the fur trade.

Throughout the following pages references to legislation give date of law or code, followed by number of section, chapter, or act containing the provision. References are sometimes omitted when provisions from various enactments are grouped in a single sentence or short paragraph.

Under the caption "Trapping" the expression "no legal restrictions" indicates only that no specific trapping provisions exist, the general trespass laws of the State not having been considered.

Under the heading "Open seasons" the dates given are, unless otherwise stated, the first day of the open season and the first day of the following close season; to find close season *reverse the dates*.

FEDERAL LAWS.

Two Federal laws have a bearing on the subject—the Lacey Act governing interstate commerce in game and the tariff act of October 3, 1913.

That part of the Lacey Act codified as section 242 of the Criminal Code (35 Stat., 1137) makes it unlawful to ship or transport "from any State, Territory, or District of the United States, to any other State, Territory, or District thereof" the bodies or parts of bodies of any wild animal or bird killed or shipped in violation of law of the State, Territory, or District in which the same were killed or from which they were shipped. This makes it unlawful to ship out of any State skins or pelts illegally taken. Packages containing furs, when shipped in interstate commerce, must be plainly marked so that the name and address of the shipper and the nature of the contents may be readily ascertained by inspection of the outside of the package.

The tariff act of 1913 places a duty of 10 per cent ad valorem on live animals shipped into the United States. Paragraph 397 of this law places on the free list animals imported for breeding purposes by a citizen of the United States; "*Provided*, that no such animal shall be admitted free unless pure bred of a recognized breed and duly registered in a book of record recognized by the Secretary of Agriculture for that breed." This act has made it impossible thus far to admit free of duty any foxes or other Canadian fur animals for propagation. Raw furs not advanced in manufacture are admitted free of duty.

ALABAMA.

Trapping.—Poisons, drugs, or chemicals may not be used in taking game or fur animals.

Open seasons.—No close season for fur animals.

Propagation.—No legal restrictions.

Bounties.—None paid.

ALASKA.

Trapping.—The Secretary of Commerce makes all regulations for taking fur animals in Alaska. Under regulations published May 24, 1915, it is unlawful

to use a "klips" trap, a steel bear trap, or any trap having a spread exceeding 8 inches; to kill any fur-bearing animal with strychnine or other poison; to trap protected fur animals at any time when the skin or pelt is not prime; to have in possession or sell or export unprime skins (such skins subject to confiscation). Shipments of furs must be reported to the Bureau of Fisheries, Department of Commerce, on blanks provided for that purpose.

Open seasons.—Land otter and mink, November 16 to April 1; marten and weasel, November 16 to March 15; muskrat, December 1 to June 1; lynx (wildcat), November 16 to March 1; fox, November 16 to March 15.¹ No close season for black bear, wolf, wolverine, ground squirrel, or rabbit. Close season on sea otter until November 1, 1920; on beaver until November 1, 1918. No open seasons in Aleutian Islands Reservation, and trapping may be done there only by special permit.²

Propagation.—Owners of establishments for breeding fur animals are subject to the same restrictions as to season for killing and condition of pelts as are trappers of wild fur-bearing animals. Fur farmers are required to furnish reports to the Bureau of Fisheries, and to allow agents of that bureau free access to establishments where animals are kept in captivity.

Within the Aleutian Islands Reservation, the Department of Agriculture grants permits to propagate fur animals, and to trap them for breeding purposes. The Afognak Reservation was set aside in 1892 mainly for the protection of sea otters.

Bounties.—Wolf, \$10 (season 1915).

ARIZONA.

Trapping.—No legal restrictions.

Open seasons.—No close season for fur animals.

Propagation.—No legal restrictions.

Bounties.—Wolf and mountain lion, \$10 each; coyote, \$2; lynx or wildcat, \$1; raccoon, 25 cents; jack rabbit, gopher, and prairie-dog, 5 cents each; paid by county (1912, ch. 82).

ARKANSAS.

Trapping.—Nonresidents are not allowed to hunt or trap in the State.³ Resident trappers using more than 10 traps are required to take out a trapper's license (fee, \$10).

Open seasons.—Bear, November 21 to January 11. Beaver and otter protected absolutely until March 11, 1920 (1915, ch. 124). No close season on other fur animals.

Propagation.—No legal restrictions.

Bounties.—County courts may offer bounty on wolf, wildcat, or panther, and fix the amount of such bounty (1885, No. 44).

CALIFORNIA.

Trapping.—Except beavers and sea otters, fur-bearing animals are included under the term "predatory animals," as defined in a recent act (1915, ch. 64). A permit is required to trap fur or predatory animals on State game refuges.

¹ South of latitude 62°.—Open season for brown bear, October 1 to July 2. North of latitude 62°.—Open season for walrus, May 10 to July 2; no close season for brown bear or sea lion. (35 Stat., 102.)

² The fur-seal fisheries, the Aleutian Islands Reservation, and the Afognak Reservation are subject to special legislative and administrative control. For specific information regarding them, application should be made to the Commissioner of Fisheries, Washington, D. C.

³ Probably permitted to trap on their own lands, in accordance with a decision of the Supreme Court of Arkansas as to hunting. (*State v. Mallory*, 83 S. W., 955.)

Open seasons.—No open season on beaver or sea otter. Seals and sea lions are protected at all times in game district 19, which includes ocean waters adjacent to the Santa Barbara Islands, except Catalina (Penal Code, sec. 637c). No close season on other fur animals.

Propagation.—No legal restrictions.

Bounties.—Mountain lion, \$20, paid by State game commission. Boards of supervisors of counties may at their discretion fix the rate and pay bounty on coyote, wildcat, fox, lynx, bear, or mountain lion. Many counties now pay a bounty on some of these animals, especially on coyotes.¹

COLORADO.

Trapping.—Hunting license required for trapping; fee, resident, \$1; non-resident, \$12. Beavers may not be trapped for fur at any time, but the owner of property damaged by the animals may apply to the State game and fish commissioner for a permit to kill them under such regulations as he may provide as to the disposition of the skins (Rev. Stat., 1909, secs. 2753, 2759b).

Open seasons.—No close season for fur animals, except beaver.

Propagation.—No legal restrictions, except as to beaver and game animals.

Bounties.—None paid by State since 1895. On petition of 50 freeholders, county commissioners may levy a tax to pay a bounty on coyote, wolf, and mountain lion.

CONNECTICUT.

Trapping.—Unlawful to trap with scented baits (1903, ch. 56); to trap on lands of another without owner's permission (1909, ch. 37); and to take animals with a snare (1913, ch. 79). Hunting license is required for trapping (except on land owned by trapper); fee, resident, \$1; nonresident, \$10; alien, \$15; with an additional 25 cents recording fee for each license. Persons under 16 years of age, while denied a hunting license, may obtain one for taking fur animals only (1907, ch. 153; 1915, ch. 240).

Open seasons.—Otter, November 1 to April 1 (1905, ch. 5); raccoon, September 2 to March 1, but landowner may kill raccoons at any time to protect crops (1915, ch. 130). No close season for other fur animals.

Propagation.—No restrictions on possession or sale of fur animals raised in captivity.

Bounties.—State bounty on fox repealed (1915, ch. 114), and also town bounty on raccoon (1915, ch. 130). Towns are permitted to pay bounty on wildcat (not over \$5), skunk, fox, weasel, wild Belgian hare, or wild German rabbit (not over \$1 on each) (1915, ch. 46).

DELAWARE.

Trapping.—Unlawful to use pitfall, deadfall, scaffold, cage, snare, trap, net, pen, baited hook, or baited field or any other similar device, or any drug, poison, chemicals, or explosives for taking birds or animals protected by the laws of this State, except muskrats, skunks, minks, and otters, and except as otherwise expressly provided. Traps or other devices unlawfully set are subject to confiscation (Rev. Stat. 1914, sec. 2378). Muskrats may not be taken during the time of any flood or freshet when such flood or freshet may cause them to leave their usual places of shelter and protection (sec. 2387). Muskrats may not be

¹ For information in regard to bounties in any county, application should be made to the county clerk.

shot at night (sec. 2380) or hunted with a dog (sec. 2388). Unlawful to destroy the nest, den, or lair of any animal protected by law (sec. 2378). Unlawful to hunt, kill, take, or destroy any protected animal or bird, except muskrat, skunk, mink, and otter, while the ground is covered with snow (sec. 2382). Unlawful to shoot at or destroy any fox while such fox is being chased by dog or dogs (sec. 2385). Owners of property may at any time destroy fur-bearing animals to protect such property (sec. 2375). Nonresident trappers are required to hold hunting license (fee, \$10.50).

Open seasons.—Skunk, mink, and otter, December 1 to March 11; muskrat, *Newcastle County*, December 1 to March 11; *Kent and Sussex Counties*, November 20 to March 16; fox, October 1 to May 1; raccoon, October 1 to February 16; opossum, October 1 to February 16 (1915, ch. 194).

Propagation.—No restrictions, provided a permit is obtained from the chief game and fish warden (fee, \$1). A restricted number of wild fur or game animals for propagating purposes may be taken under permit.

Bounties.—None paid.

DISTRICT OF COLUMBIA.

No legislation relating to fur animals.

FLORIDA.

Trapping.—No legal restrictions.

Open seasons.—Beaver and otter, November 1 to February 1 (1905, No. 57).

No close season for other fur animals.

Propagation.—No legal restrictions.

Bounties.—None paid.

GEORGIA.

Trapping.—Permission to trap on lands of another is necessary, but no license is required.

Open seasons.—Opossum, October 1 to March 1 (C. Code 1911, sec 590); fox, *Habersham County*, September 1 to May 15 (1914, No. 304). Fur animals not otherwise protected.

Propagation.—No legal restrictions.

Bounties.—None paid.

HAWAII.

Hawaii has no wild animals valuable for fur. There are no restrictions on the propagation of fur animals, except that mongooses and rabbits may not be kept or bred. Pet rabbits may be raised, if kept in confinement (1905, ch. 37).

IDAHO.

Trapping.—No restrictions, except in State game preserves.

Open seasons.—No open season for beavers, but owner of property destroyed by these animals may obtain a permit to kill them from the State fish and game warden. Skins of animals so killed must be sent to the warden, who shall sell them and apply the proceeds to the State game fund (1911, ch. 62). No close season on other fur animals, except in State game preserves.

In Black Lake Game Preserve, beaver, otter, marten, fisher, fox, mink, and wolverine are protected at all times; mountain lion, bear, lynx, wolf, coyote, and wildcat may be destroyed by game warden or duly authorized person (1915, ch. 9).

In Payette Game Preserve, bear, lynx, wolverine, fox, otter, beaver, marten, mink, and fisher are protected at all times; mountain lion, timber wolf, coyote, and wildcat may be killed by game wardens or duly authorized persons (1909, H. B. 242).

Propagation.—No restrictions, except in game preserves.

Bounties.—Coyote, lynx, or wildcat, \$2.50 each; bear or wolf, \$10; mountain lion, \$25; paid from predatory wild animal fund administered through the State live stock sanitary board (1915, ch. 73).

ILLINOIS.

Trapping.—No legal restrictions.

Open seasons.—Raccoon, mink, muskrat, skunk, opossum, and otter, November 1 to April 1 (1915, S. B. 439, sec. 4).

Propagation.—Permit is required to conduct a fur farm on which protected animals are reared.

Bounties.—None paid by State. Counties may at their discretion pay bounty on groundhog and crow (1909, H. B.'s 686, 687).

INDIANA.

Trapping.—Protected fur animals may be killed at any time when destroying property. Muskrat houses may not be destroyed (1911, ch. 6).

Open seasons.—Mink, raccoon, opossum, skunk, and muskrat, November 1 to April 1 (1911, ch. 6).

Propagation.—All birds and animals raised in captivity are considered domestic stock, and the owner may possess, sell, ship, transport, or otherwise dispose of them without regard to laws regulating the killing and disposition of wild birds and animals (1915, H. B. 37).

Bounties.—Crow, 10 cents each; paid by counties (1911, ch. 183). Boards of county commissioners are authorized at their discretion to pay bounty on wolf, woodchuck, owl, or hawk (Ind. Stat., Burns, sec. 7871).

IOWA.

Trapping.—Hunting license required for trapping; fee, resident \$1, non-resident \$10.50 (1915, S. F. 621).

Open seasons.—Beaver, mink, otter, muskrat, December 1 to April 1 (36 G. A., sec. 2553); other fur bearers not protected.

Propagation.—No legal restrictions.

Bounties.—Adult wolf, \$20; wolf cub, \$4; wildcat, \$1; paid by county (1913, ch. 189). Boards of supervisors of counties may allow bounty on crow, ground hog, pocket gopher, or rattlesnake.

KANSAS.

Trapping.—The owner or legal occupant of land may destroy fur-bearing animals protected by law when such animals are destroying poultry or damaging other property (1911, ch. 198).

Open seasons.—Muskrat, skunk, mink, raccoon, opossum, and civet cat, November 15 to March 16. No open season for beaver or otter until 1921 (1911, ch. 198).

Propagation.—Permits for raising fur animals protected by law are issued by State game warden.

Bounties.—Coyote, \$1; wolf, \$5; crow and pocket gopher, 5 cents each; paid by county.

KENTUCKY.

Trapping.—Unlawful to hunt or trap on lands of another without written consent of owner.

Open seasons.—No close season for fur animals.

Propagation.—No legal restrictions.

Bounties.—None paid.

LOUISIANA.

Trapping.—License for trapping is required; fee, resident, \$2; nonresident, \$15 (1914, ch. 293). Muskrats may be taken at any time within 6 miles of any levee, and may be killed by the owner of land upon which they are destroying property. Skins of animals killed in open season may be possessed in close season. Wild ducks may not be used for trap bait (1912, ch. 204).

Open seasons.—Bear, November 1 to February 1 (may not be trapped); beaver, muskrat, mink, otter, raccoon, skunk, fox, and opossum, November 1 to February 16 (1912, ch. 204).

Propagation.—No restrictions, except as to capture during close season.

Bounties.—None paid.

MAINE.

Trapping.—Trappers in unorganized townships of the State are required to take out an annual license (fee, \$5) and on or before December 15 of each year must make such report as the commissioners of inland fisheries and game may require (1911, ch. 64). Any person who sets a trap in an organized county or incorporated place must obtain written consent of the owner or occupant of land on which the trap is set, and must visit such trap at least once in every 24 hours and remove animals caught (1915, ch. 277). All traps must be plainly marked with owner's name and address either by having the same stamped on the trap or on a metal tag firmly attached to it (1915, ch. 277). A set bear trap must have a notice that it is set posted conspicuously near it (1915, ch. 277).

Dealers in skins of fur animals must each year take out a license (fee, \$2) to engage in this trade and must keep a record of transactions and forward same to the commissioners of inland fisheries and game on or before December 20 (1915, ch. 277). Putting out poison for wolves, foxes, dogs, or other animals is forbidden under penalty of fine or imprisonment (1909, ch. 134).

Traps may not be set within 25 feet of a muskrat house. A special law protects muskrats on Lower Kezar Pond and certain adjacent territory for four years from July 8, 1915 (1915, ch. 19). On complaint by land owners of damage done by beavers, the commissioners of inland fisheries and game have authority to declare an open season for beavers on lands where damage occurs (1915, ch. 222). Any person may lawfully kill any wild animal, except beaver, found destroying his property (1915, ch. 334).

Open seasons.—All fur animals (except beaver, muskrat, bear, bobcat, loup cervier, Canada lynx, and weasel), November 1 to May 1. No open season on beaver, except when declared by the commissioners of inland fisheries and game. No close season on bear, bobcat, Canada lynx (loup cervier), or weasel (1913, ch. 206).

Propagation.—No legal restrictions, except that protected fur animals may not be captured in close season for stocking fur ranches, and that no animals may be imported into the State without permit.

Bounties.—Bobcat and Canada lynx (loup cervier), \$4 each; paid by State. Claim for bounty to be made within five days after killing or return from trip on which killing was done (1913, ch. 206). The bounty on bears in certain counties was recently repealed (1913, ch. 36).

MARYLAND.

While the State has recently adopted a uniform open season for game, the counties still regulate the taking of fur animals. The State law protecting otter, raccoon, and muskrat from April 1 to January 1 (1900, ch. 371) was amended until it applied to only 6 counties (1912, ch. 843), and some of these have local laws which take precedence. Local laws providing protection to fur animals or regulating their capture are in force in the following counties:

Allegany County.—Bounty on wildcat, \$2; fox, \$1; hawk or hoot owl, 50 cents (1910, ch. 616).

Anne Arundel County.—Raccoon, open season, October 2 to February 1; muskrat, December 2 to March 1. Unlawful at any time to destroy muskrat dens or houses, unless the animals are destroying property (1906, ch. 589).

Baltimore County.—Unlawful to set traps, except from November 10 to December 21. Unlawful to pursue or kill raccoons and opossums, except from October 1 to February 23 (inclusive); unlawful to hunt them on Sundays or when snow covers the ground. Permits to take certain predatory fur animals when destroying property may be obtained, but such permits may be revoked at any time by the chief game warden (1912, ch. 751).

Caroline County.—Muskrat, open season, December 15 to April 1; raccoon, September 15 to March 31; otter, December 15 to April 1 (1902, ch. 157). Unlawful for nonresidents to trap without license (fee, \$4.50). Unlawful to dig into or destroy muskrat homes or dens, except when animals are destroying property (1902, ch. 157). Unlawful to use reflector or artificial light in taking muskrats or otters (1904, ch. 91).

Cecil County.—Muskrat, open season, December 1 to March 1; may be taken only by trapping (1914, ch. 39). Trapping on lands of another without written permission is unlawful (1914, ch. 464).

Charles County.—Unlawful to shoot muskrats on Nanjemoy Creek and tributaries by aid of light (1912, ch. 862).

Dorchester County.—Raccoon and otter, open season, January 1 to April 1 (State law); muskrat, January 1 to March 16 (local law). Unlawful to shoot muskrats (1900, ch. 205), or to use artificial light in taking them. Bounty on crow, 5 cents.

Frederick County.—Bounty on wildcat, \$2; mink or fox, \$1; weasel, owl, or hawk, 50 cents.

Harford County.—Trapping forbidden, except from November 10 to December 10, inclusive. Unlawful to trap on private property without permission or to export raccoons from county. Bounty of 50 cents each on chicken hawk, pigeon hawk, booby owl, or weasel (1914, ch. 365).

Kent County.—Otter, raccoon, and muskrat, open season, January 1 to April 1 (State law). Unlawful to use light in hunting muskrats.

Montgomery County.—Raccoon and opossum, open season, October 15 to January 15; muskrat, November 15 to March 1. Nonresident requires license to hunt raccoon or opossum (fee, \$15.50). Setting a snare or trap in or about a fox den is unlawful. Bounty on hawks, 40 cents (1912, ch. 438).

Prince Georges County.—Unlawful to hunt, shoot, or trap muskrats in Aquasco District, between March 15 and January 1, or to spear them at any time (1910, ch. 688).

Queen Anne's County.—Otter, raccoon, and muskrat, open season, January 1 to April 1 (State law).

Somerset County.—Otter and raccoon, open season, January 1 to April 1 (State law); muskrat, January 1 to March 16 (local law). Unlawful at all times to shoot muskrats.

Talbot County.—Otter and muskrat, open season, December 16 to March 16. Dealers may have skins of either in possession up to March 31. Unlawful to take otter or muskrat at night, except in traps (1912, ch. 785).

Washington County.—Unlawful to shoot foxes while they are being chased by dogs.

Wicomico County.—Otter, mink, and muskrat, open season, December 15 to March 1. Unlawful to use light in hunting muskrats (1894, ch. 51).

Worcester County.—Muskrat, otter, and mink, open season, December 15 to March 1. Unlawful to trap on lands or marshes of another without permission (1910, ch. 239). Unlawful to chase fox with dogs, March 10 to September 1, or to shoot any fox while it is pursued by dogs (1904, ch. 652).

MASSACHUSETTS.

Trapping.—Poison may not be used to kill animals, except rats, woodchucks, or other pests on one's own premises. The use of steel traps with spread of over 6 inches, and "choke" traps with greater opening than 6 inches is unlawful. Traps may not be set on lands of another without written consent. Traps must be visited at least once in 24 hours. Introduction of foxes or raccoons into Dukes County is prohibited (Rev. Laws 1902-1908, ch. 92.)

Open seasons.—No close season for fur animals.

Propagation.—No legal restrictions.

Bounties.—Wildcat or lynx, \$5; paid by town, but refunded by county (1908, ch. 344).

MICHIGAN.

Trapping.—License required for trapping; fee, resident, \$1; nonresident, \$10 (1913, No. 108). A special license (fee, \$10) is required for trapping beavers. Such license permits the taking of 15 beavers, not more than 4 from a single colony. Unlawful to destroy beaver houses or dams or to have carcass or skin in possession without license seal attached (1911, No. 206). Unlawful to destroy muskrat house or to set trap within 6 feet of such house or to use firearms or explosives in taking muskrats. Unlawful to possess carcass or skin of any fur animal killed in close season. Fur animals, except beavers, may be destroyed on one's own premises to protect property (1909, No. 183). Unlawful to trap in State game refuges (1913, No. 360).

Open seasons.—Beaver (under license), November 1 to May 15; otter, fisher, marten, fox, mink, raccoon, and skunk, November 1 to April 1; muskrat, November 1 to April 15. No close season on wolf, lynx, and wildcat (1909, No. 183).

Propagation.—Protected fur animals may not be taken in close season for breeding purposes without permit. Permit is also required to keep them in captivity during close season and to sell and transport them without the State.

Bounties.—Grown wolf, \$25; wolf's whelp under the age of 6 months, \$10; wildcat, \$3; lynx, \$5; paid by county and one-half refunded by State (1909, No. 304).

MINNESOTA.

Trapping.—Unlawful to molest or destroy muskrat, mink, or beaver house or den at any time or to hunt these animals with dog, or dogs, provided, that in the open season for muskrats their houses may be opened to set traps, but not in such manner as to injure them as habitations for muskrats. If any of these animals are damaging property the owner may obtain a permit to kill them and destroy their houses or dams. Nonresidents must obtain license to trap mink, beaver, muskrat, or otter; fee, \$10. Skins or pelts legally taken may be possessed, bought, or sold at any time (1913 ch. 32, sec. 4796).

Open seasons.—Mink and muskrat, December 1 to April 15. Permanent close season on beaver (1915, ch. 32, sec. 4796).

Propagation.—Permits to breed or domesticate mink, muskrat, skunk, and raccoon are issued by the State game and fish commissioner; fee, 1 cent for each animal in possession. Also bond (\$500) is required, as guarantee that no wild

animals will be captured during close season for other than breeding purposes. Persons having in lawful possession such fur-bearing animals have a property right therein and it is unlawful for others to enter inclosures where the animals are confined or molest them, under such penalties as would result were they ordinary domestic live stock (1913, ch. 32, sec. 4797).

Bounties.—Grown wolf or coyote, \$7.50; cub, \$3; paid by county, refunded by State (1907, ch. 381). County or town boards may by resolution offer bounty on gopher, ground squirrel, ground hog, rattlesnake, crow, or blackbird (1909, ch. 48; 1911, ch. 220).

MISSISSIPPI.

Trapping.—No legal restrictions.

Open seasons.—Bear, November 15 to March 1 (Code, sec. 2324).

Propagation.—No legal restrictions.

Bounties.—None paid.

MISSOURI.

Trapping.—Wild fur-bearing animals may be destroyed at any time and in any way to protect premises from their depredations (Rev. Stat. 1909, sec. 6521a). Unlawful to offer pelts of protected animals for sale if taken out of season (1913, p. 348). Written permission required to trap on lands of another (1913, p. 224). Use of poison prohibited in taking any protected animal (1915, H. B. 605).

Open seasons.—All fur animals, November 1 to February 1 (sec. 6521a).

Propagation.—Permits to capture for propagating purposes may be obtained from the State game and fish commissioner.

Bounties.—Adult wolf or coyote, \$8; young wolf or young coyote, \$3; paid by county and one-half refunded by State (sec. 10586).

MONTANA.

Trapping.—No legal restrictions, except as to trapping on State game preserves, where license (fee, \$5) is required.

Open seasons.—No close seasons for fur animals, except beaver. Unlawful to take beavers at any time, except by owner of property for its protection. Unlawful to sell beaver skins or offer them for sale (Code, secs. 8783, 8785).

Propagation.—No legal restrictions.

Bounties.—Grown wolf, \$15; wolf pup, \$3; coyote or coyote pup, \$3; mountain lion, \$10; paid from State bounty fund raised by tax on live stock (1911, ch. 50).

NEBRASKA.

Trapping.—Unlawful to trap on premises of another without consent of owner (Code, sec. 2668).

Open seasons.—Muskrat, mink, or otter (on premises of another), February 15 to April 15. Beaver, no open season, but if the animals are damaging property a permit to destroy them may be obtained from the State game and fish commission (Code, sec. 2668). No close season for other fur animals; any except beavers may be taken at any time on one's own premises.

Propagation.—No legal restrictions.

Bounties.—Such counties as have at any general election voted to pay bounties, pay for wolf, \$3; wildcat or coyote, \$1; mountain lion, \$3 (R. S., 1913, secs. 478-484).

NEVADA.

Trapping.—No legal restrictions.

Open seasons.—No close season except on beavers, which may not be taken until April 1, 1920 (1915, ch. 256).

Propagation.—License (fee, \$10, paid annually to county) required from those who wish to propagate game or fur animals (except beaver). Animals on breeder's own lands may be taken at any time for propagation, and those held in captivity by holder of license may be sold at any time. No bounty may be collected on noxious species raised in captivity (1915, ch. 256).

Bounties.—Mountain lion, \$5; lynx or wildcat, \$2; coyote, 50 cents; paid by county. Not less than 5 scalps may be presented at one time by claimant (1913, ch. 23). Counties pay bounty of 1½ cents each for pocket gophers, when at least 100 heads are presented at one time (1893, ch. 20).

The State board of live stock commissioners is authorized to pay bounty from funds derived from tax on horses, cattle, and hogs. The rewards are, for coyote, coyote pup, wildcat, or lynx, 75 cents each; mountain lion, \$5 (1915, ch. 268).

The State board of sheep commissioners is authorized to pay bounty from funds derived from tax on sheep, the payments being the same as those made by the board of live stock commissioners (1915, ch. 247).

NEW HAMPSHIRE.

Trapping.—Fur-bearing animals defined as beaver, otter, marten, sable, mink, raccoon, fisher, fox, skunk, and muskrat. The right of anyone to kill predatory fur animals at any time when destroying domestic animals or fowls is conceded. Skins legally taken may be bought or sold at any time. No person may destroy a muskrat house or set a trap therein, thereon, or at the entrance thereof. No person may trap upon lands of which he is not owner or lessee. All traps must be legibly marked or stamped with trapper's name, and must be visited at least once in 24 hours. It is an offense punishable by a fine to take traps of another or remove fur animals from them. The use of spring guns is unlawful. Bear traps must be safeguarded in a substantial manner. License for trapping except on private lands is required—fee, resident, \$1; nonresident, \$15 (1915, ch. 133).

Open seasons.—All fur-bearing animals, except beaver, November 1 to March 1. No open season for beaver. Raccoons and foxes may be taken by use of dog and gun during October (1915, ch. 133).

Propagation.—No restrictions other than those imposed by the trapping regulations.

Bounties.—Bear, \$5 (1895, ch. 121); hedgehog, 20 cents (1911, ch. 93); wild cat, \$2 (1915, ch. 133); paid by State.

NEW JERSEY.

Trapping.—Skunks, minks, muskrats, and otters may not be taken in close season, except that muskrats may be destroyed by owner of canal or dam which they are destroying. Muskrats may be taken by trap only, except in Salem County, above Mill Creek, where they may be taken in open season by firearms and light. It is unlawful to disturb the lodge or nesting chamber of muskrats, to molest traps set by another, or to appropriate or take animals caught in such traps (1913, ch. 126, 161).

Open seasons.—Skunk, mink, muskrat, and otter, November 15 to April 2 (1913, ch. 126); raccoon, October 1 to December 16 (1915, ch. 216). Beaver, unlawful to trap, take, kill, or have in possession at any time (1903, ch. 246). The board of fish and game commissioners may grant permits to hunt foxes with hound and firearms from the last day of the open season for game (Dec. 15) to March 31 (1913, ch. 157).

Propagation.—No restrictions except those imposed by close seasons, during which wild animals may not be taken for breeding purposes.

Bounties.—Fox, \$3; paid by only a few counties (1902, ch. 112, amended by 1906, ch. 320).

NEW MEXICO.

Trapping.—No legal restrictions.

Open seasons.—No close season on fur animals, except beavers, which are protected at all times.

Propagation.—No restriction other than that respecting the capture of beavers.

Bounties.—Coyote, wildcat, or lynx, \$2; wolf, \$15; panther, or mountain lion, \$10; paid from county wild animal fund, raised by tax on live stock (1909, ch. 104).

NEW YORK.

Trapping.—License required for hunting or trapping; fee: resident, \$1.10; nonresident, \$20.50; nonresident taxpayer, \$10.50. Muskrat houses may not be molested, injured, or disturbed, nor the animals shot at any time. Skunks may not be taken by digging or driving them from dens by chemicals; if injuring property, they may be taken at any time and in any manner (1914, ch. 92).

Open seasons.—Mink and sable, November 10 to April 21; skunk, November 10 to February 11; muskrat, November 10 to April 21; raccoon (in any manner), November 10 to April 21; raccoon (except by traps), October 1 to April 21). No open season for beaver (1914, ch. 92).

Propagation.—All protected fur animals may be kept alive in captivity for propagation and sale, provided a license be obtained from the conservation commission (fee, \$5). No fur-bearing animals may be kept which are taken wild during close season for such animals, nor may they be disposed of during close season (1914, ch. 92).

Bounties.—Panther, \$20 paid by State; none paid since May, 1884.

NORTH CAROLINA.

Trapping.—Otters, muskrats, or minks may not be trapped nor their skins sold by anyone who has not resided in the State at least two years (1905, ch. 394).

Open seasons.—Open seasons for hunting and trapping are fixed by local laws; more than half of the 100 counties have local laws relating to fur animals.

Propagation.—No legal restrictions.

Bounties.—None now paid by the State.

Local trapping regulations.—The following local regulations are in force (September, 1915):¹

Alamance County.—Opossum, open season, October 1 to February 1 (sec. 1883); fox, same open season. Unlawful to carry fox out of State in close season (1911, ch. 654.) A misdemeanor to take foxes save only with dogs or dog (1909, ch. 616).

¹ The references are to public local laws of various years or to sections of Pell's Revisal of 1908, ch. 40.

- Anson County.**—Fox, open season, August 1 to April 1 (1911, ch. 621).
- Ashe County.**—All fur animals, open season, November 1 to February 1 (1913, ch. 560).
- Bertie County.**—Opossum and raccoon, open season, October 1 to February 1. Trapping game with steel or log trap forbidden (1915, ch. 555).
- Bladen County.**—Opossum and raccoon, open season, October 31 to January 31 (1911, ch. 123). Setting traps in Colly Township regulated (1909, ch. 436).
- Buncombe County.**—Unlawful to trap on lands of another (1913, ch. 560).
- Burke County.**—Fox, close season in that part of the county lying south of Catawba River and Cleveland, March 1 to December 1, except when the animals are committing depredations (1907, ch. 388).
- Caswell County.**—Opossum, open season, October 1 to February 1 (sec. 1883).
- Chatham County.**—Opossum, open season, October 1 to February 1 (1911, ch. 756); fox, open season, September 1 to February 1 (1911, ch. 135).
- Cherokee County.**—Unlawful to hunt (except for foxes and wolves) on lands of another without written permission of owner or agent (1907, ch. 452).
- Clay County.**—Otter, open season, November 1 to April 1 (sec. 1883); fox, raccoon, and opossum, October 15 to January 15 (1911, ch. 200).
- Columbus County.**—All fur animals, open season, January 1 to April 1 (except that in Bug Hill and Lee Townships it is December 1 to March 1). Steel traps of not less than 14-inch spread may be used at any time provided notice of their setting is posted (1909, ch. 417).
- Craven County.**—Otter, mink, muskrat, raccoon, and skunk, open season, December 1 to April 1. Owner of property may kill at any time to protect such property. (1915, ch. 37).
- Cumberland County.**—A bounty of \$5 is paid for each bear killed in Cedar Creek and Beaver Dam Townships (1905, ch. 176).
- Currituck County.**—Otter, raccoon, opossum, mink, and muskrat, open season, November 1 to April 1 (1913, ch. 560). Unlawful to shoot otter or muskrat in open season after sunset or before sunrise on east side of Currituck Sound (1909, ch. 537).
- Duplin County.**—Fox, open season, September 15 to February 15 (1911, ch. 407).
- Durham County.**—Opossum, open season, October 1 to February 1 (sec. 1883).
- Edgecombe County.**—Opossum, open season, October 1 to January 1 (1911, ch. 189).
- Forsyth County.**—Opossum, open season, October 1 to February 1 (1913, ch. 560).
- Franklin County.**—Opossum, open season, October 1 to February 1 (sec. 1883); fox, October 15 to March 1 (1913, ex. sess., No. 169).
- Gates County.**—All fur animals, open season, November 15 to April 1 (1911, ch. 745).
- Graham County.**—Opossum, open season, October 1 to February 1 (sec. 1883).
- Greene County.**—Opossum, open season, October 1 to February 1 (1907, ch. 598).
- Guilford County.**—Opossum, open season, October 1 to February 1 (sec. 1883).
- Halifax County.**—Raccoon and opossum, open season, November 15 to March 1; fox, September 15 to March 1. Unlawful to trap on lands of another without permission (1913, ch. 591).
- Harnett County.**—Opossum, open season, October 1 to January 1 (sec. 1883).
- Haywood County.**—All fur animals (except bear), open season, November 15 to January 15. No close season on bear, and fur animals may be destroyed at any time when preying on poultry, pigs, or lambs (1913, ch. 366).
- Henderson County.**—Fur animals, except wildcat, opossum, and mole, are protected by a close season from March 15 to November 15 (1913, ch. 560). The board of county commissioners are authorized to add to the list of protected fur-bearers, and fix the open season for killing them (1915, ch. 677). Trapping on lands of another without permission of owner or agent is unlawful (1915, ch. 135).
- Hoke County.**—Unlawful to hunt or trap on lands of another without permission. Nonresidents require license (fee, \$15, unless for hunting or trapping deer, wild turkeys, or foxes, when the fee is \$25) (1915, ch. 459).
- Johnston County.**—Opossum, open season, in Bentonville, Boone Hill, and Wilder Townships, November 1 to March 1 (1913, ch. 648).
- Lee County.**—Fox, open season, October 1 to March 1; unlawful to carry out of State in close season (1911, ch. 291).
- Lincoln County.**—Opossum, open season, October 1 to January 1 (sec. 1883); fox, November 15 to February 1, except that when doing damage to fowls or other live stock foxes may be killed at any time (1913, ch. 359).
- McDowell County.**—Opossum and raccoon, open season, October 15 to March 1 (1913, ch. 70).
- Mecklenburg County.**—Opossum, open season, October 1 to February 1; fox, November 15 to February 1. Foxes may be killed at any time if destroying property of value (1911, ch. 543).

Mitchell County.—Opossum and ground hog, open season, October 1 to February 15 (sec. 1883); raccoon, October 15 to February 1 (1913, ch. 369). Bounty of 50 cents each on weasel, mink, and horned owl (1913, ex. sess., No. 99).

Montgomery County.—Opossum, open season, October 1 to January 1 (1911, ch. 102); fox, October 15 to January 15 (1911, ch. 291).

Moore County.—Opossum, open season, October 1 to February 1 (sec. 1883); fox, October 1 to March 1 (1911, ch. 291); unlawful to carry fox out of State in close season.

Orange County.—Opossum, open season, October 1 to February 1 (sec. 1883).

Pamlico County.—Opossum, open season, October 1 to February 1 (sec. 1883).

Pasquotank County.—Raccoon, opossum, mink, muskrat, wildcat, and bear, open season, November 1 to April 1 (1913, ch. 369).

Pender County.—Fox, open season, September 15 to February 15 (1911, ch. 407).

Polk County.—Opossum, open season, October 1 to February 1 (1915, ch. 454).

Randolph County.—Opossum, open season, October 1 to January 1 (1911, ch. 24).

Richmond County.—Raccoon, open season, September 1 to April 1 (sec. 1883a); fox, October 1 to March 1 (may be taken only with dogs) (1913, ch. 520).

Robeson County.—All fur animals (including squirrel), open season, October 15 to March 1; unlawful to take them at any time by net, snare, or trap, except on one's own premises (1915, ch. 410).

Rockingham County.—Opossum, open season, October 1 to February 1; may be destroyed at any time by landlord or renter to protect crops (1911, ch. 756). Unlawful to shoot or trap fox (1905, ch. 752).

Rutherford County.—Fox, open season (in three townships—Golden Valley, Logans Store, and Duncans Creek), November 1 to February 1; to be hunted with dogs only (1913, ch. 591). No close season in other townships.

Sampson County.—Opossum, open season, October 1 to March 1 (1911, ch. 19).

Scotland County.—Unlawful to trap or hunt on private lands without permission of owner.

Stokes County.—Fox law of 1913 repealed (1915, ch. 551).

Surry County.—Opossum, open season, October 1 to January 1 (1915, ch. 289).

Swain County.—Mink, otter, muskrat, skunk, raccoon, and opossum, open season, November 15 to February 15; owner of property may kill at any time to protect it (1915, ch. 772).

Vance County.—Fox, raccoon, opossum, open season, November 15 to March 1, but may be run down and caught by dogs at any time (1913, ch. 718).

Wake County.—Raccoon and opossum, open season, October 1 to February 1 (1913, ch. 225).

Warren County.—Fox, no close season (1913, ch. 560).

Watauga County.—All fur animals (except mink and muskrat), open season, November 1 to March 15. They may be taken in open season only with dogs and gun or either. Mink and muskrat not protected (1913, ch. 533).

Wayne County.—Fox, open season, September 1 to March 1 (1909, ch. 912).

Wilkes County.—Opossum, open season, October 15 to March 1 (at night), but may be shot at any time when killing fowls or pigs. Fox, open season, October 1 to February 15, except that they may be killed in close season when destroying fowls; may not be shot at any time except to protect property (1913, ch. 77).

Yadkin County.—Opossum, open season, October 1 to March 1 (1911, ch. 71).

NORTH DAKOTA.

Trapping.—A license is required to trap except on one's own lands; fee, resident, \$1; nonresident, \$25. The protected fur animals are mink, muskrat, otter, and beaver; but minks and muskrats may be killed at any time by owner of property destroyed by them. Muskrat houses are protected at all times. The owner of property destroyed by beavers may appeal to the State game and fish board and have the animals removed (1915, H. B. 300).

Open seasons.—Mink and muskrat, November 16 to April 15. No open season for beaver or otter (1915, H. B. 300). No close season for other fur animals.

Propagation.—The State game and fish board issues permits to breed and domesticate protected birds and animals and also permits to ship them when raised in captivity. Annual reports are required of licensed breeders (1915, H. B. 300).

Bounties.—Wolf or coyote (killed within State), \$2.50 each; paid from fund raised by direct taxation on all property (1903, ch. 207).

OHIO.

Trapping.—The close season for certain fur animals does not prohibit owners or tenants of land from destroying them to protect property. Digging out skunk dens or smoking the animals therefrom is unlawful, as is also the possession of green skunk pelts in close season (1913, H. B. 80).

Open seasons.—Raccoon, November 1 to March 2; muskrat, January 1 to April 2 (1911, H. B. 32); skunk, November 15 to February 2 (1913, H. B. 80); fox, October 2 to January 10 (1911, H. B. 407).

Propagation.—No restrictions, except those which prevent capture of wild stock in close season.

Bounties.—Townships pay a bounty of \$1 each on certain hawks (1915, H. B. 79); 20 cents per dozen on English sparrows; and, under certain conditions, 10 cents each on ground hogs (P. & A. Code, 1912, secs. 5824-5827).

OKLAHOMA.

Trapping.—No legal restrictions.

Open seasons.—No close season, except on bears, which may not be killed or captured at any time in Comanche, Caddo, Kiowa, Major, and Blaine Counties (1915, H. B. 589).

Propagation.—The State game warden issues permits to propagate fur-bearing animals, game, and fish; cost \$2, together with fees for tagging. Licensed breeders may sell and transport animals raised in preserves under rules prescribed by the warden (1915, S. B. 333).

Bounties.—County commissioners are authorized to offer bounty on gray wolf (\$3) and coyote (\$1) (1890, S. B. 458).

OREGON.

Trapping.—License (fee, \$1) is required of all persons over 16 years of age to trap on lands not their own. No flesh of game animal or bird may be used to bait traps. Unlawful to remove or disturb traps of a licensed trapper on public domain or on lands where he has permission to trap. Licensed trappers are required to make annual reports of number of animals caught and receipts for fur sold. If beavers or other fur animals damage property, permits to kill them may be obtained from the State board of fish and game commissioners. Skins of such animals are the property of the State, to be sold and the proceeds used in paying for damage to property. Unlawful to destroy muskrat house, except where it obstructs ditch or watercourse (1913, ch. 282).

Open seasons.—Mink, otter, fisher, marten, and muskrat, November 1 to February 28, inclusive. No open season for beaver, and none for fur animals in State game preserve (1913, ch. 232).

Propagation.—Permits to keep fur-bearing animals may be obtained from the State board. No wild fur animals may be taken for propagating purposes in close season nor may those held in captivity under permit be sold in that season. Yearly reports to the State board are required (1913, ch. 232).

Bounties.—Coyote, \$1.50; gray or black wolf, \$5 (pup of same, \$2.50); timber wolf or timber wolf pup, \$2.50; bobcat, wildcat, or lynx, \$2; mountain lion, cougar, or panther, \$10 (1909, ch. 113); paid by State. The State board is empowered to pay additional bounties, at its discretion, on any predatory animal in order to protect game (1913, ch. 232); under this act the State board now pays for wolf, \$20; for cougar, \$15.

PENNSYLVANIA.

Trapping.—Unlawful to trap bears, and only one may be killed in a season. No steel traps larger than No. 3 size may be used for trapping wildcats or other fur animals. License not required for trapping, but hunting license required for killing raccoons or bears, which are regarded as "game" animals.

Open seasons.—Bear, October 15 to December 16; raccoon, October 15 to January 1. No open season for beaver. Foxes may not be trapped, shot, snared, or poisoned in Delaware County (1915, P. L. 146).

Propagation.—No legal restrictions on raising fur animals, except that possession and breeding of ferrets is unlawful except under license from the State board of game commissioners; fee for license to breed and sell ferrets, \$25; to possess a ferret without breeding, \$1 (1915, P. L. 146).

Bounties.—Wildcat, \$8; fox, \$2; mink, \$1; weasel, \$1; paid from special fund created by setting aside one-half the receipts by the board of game commissioners from gun licenses, fines, etc. (1915, P. L. 126).

PORTO RICO.

Porto Rico has no wild fur animals.

RHODE ISLAND.

Trapping.—Hunting license is required for trapping, except on one's own lands; fee, resident, \$1; nonresident, \$10; alien, \$15; together with an additional fee of 15 cents for issuing license. Unlawful to trap on posted lands or on lands of another without written permission. Unlawful to set wire snares, or to use steel traps with teeth or with spread over 6 inches, or choke traps with greater opening than 6 inches. Traps must be concealed so as not to endanger domestic animals and must be visited at least once in 24 hours.

Open seasons.—Skunk, muskrat, raccoon, and mink, November 10 to April 15. Landowners may kill protected animals on their own lands at any time (1915, ch. 1230).

Propagation.—No legal restrictions.

Bounties.—Fox, \$3; crow and certain hawks and owls, 25 cents; paid by State.

SOUTH CAROLINA.

Trapping.—Unlawful to hunt or trap on lands of another without his consent. Unlawful at any time to shoot or trap foxes in York, Union, Chesterfield, Edgefield, Lee, Cherokee, Chester, Richland, Abbeville, Calhoun, Sumter, and Orangeburg Counties. Nonresidents (except freeholders) require license (fee, \$5) to chase foxes in Chester, York, Sumter, and Union Counties (C. Code, sec. 740).

Open seasons.—Fox, in 12 counties (named above), September 1 to February 15 (C. Code, sec. 740).

Propagation.—No legal restrictions.

Bounties.—None paid.

SOUTH DAKOTA.

Trapping.—Hunter's license (fee, \$1) required for trapping by resident; trapping license (fee, \$10) required for nonresident to take mink, muskrat, otter, or beaver (1909, ch. 183). Persons whose property is damaged by any of these animals may kill them at any time. Muskrats destroying public highways may be killed by town supervisor or person delegated by him. Skins of fur animals killed out of season may not be bought or sold.

Open seasons.—Mink, muskrat, otter, and beaver, November 15 to April 1 (1909, ch. 183).

Propagation.—No restrictions, except that protected animals may not be taken for breeding purposes in close season.

Bounties.—Grown wolf, \$5; wolf pup, \$2; mountain lion, \$3; coyote, \$2; paid by State. Should bounty claims for any year exceed the appropriation for that year they are paid pro rata (1905, ch. 177).

TENNESSEE.

Trapping.—Owner of land may hunt or trap on such land at any time; others may do so only with the written consent of owner. Steel traps must be placed at least 12 or more inches within entrance to a hole, cave, den, or hollow log. Traps and deadfalls must be inspected within each 36 hours, and captured animals removed (1915, ch. 152).

Open seasons.—For trapping fur bearers off one's own land, from noon October 15 to noon January 15 (1915, ch. 152).

Propagation.—No legal restrictions.

Bounties.—Wolf or panther, \$2 certificate issued by county court, the amount to be applied on payment of taxes (1889, ch. 200).

TEXAS.

Trapping.—No license required for trapping, but on posted lands consent of owner is necessary (1915, ch. 47).

Open seasons.—No close season for fur animals.

Propagation.—No legal restrictions.

Bounties.—Wolf, \$2; wildcat, \$1; jack rabbit, 5 cents; paid by county, but one-half is refunded by the State, the State, however, being liable only to the extent of its appropriation, which is \$100,000 (1915, ch. 47).

UTAH.

Trapping.—No license required for trapping. State fish and game commissioner may trap beavers damaging farms or crops and sell the animals or skins for the benefit of the fish and game fund (1915, ch. 118).

Open seasons.—No close season on fur animals except otters and beavers, which are protected at all times (1915, ch. 118).

Propagation.—No restrictions, except as to otter and beaver. Otters or beavers may be kept in captivity in a licensed private preserve (fee, \$25 per year). Permits may be obtained to capture wild animals for stocking a licensed preserve, but one-fourth of the natural increase must be given to the State, and none of the animals may be sold (1915, ch. 118).

Bounties.—Wolf, bear, or mountain lion, \$15; coyote, wildcat, or lynx, \$1.50; paid from State bounty fund, raised by tax on live stock and by direct appropriation (1913, ch. 92). County commissioners may offer bounty on certain other animals and birds if they think it for the best interests of the county (1908, ch. 7).

VERMONT.

Trapping.—License is required for trapping; fee, resident, 60 cents; nonresident, \$10.50. Persons trapping on inclosed lands of another must inform owner of location of traps and must visit traps at least once in 24 hours. The use of

spring guns is prohibited, and bear traps must be carefully safeguarded. Skins of fur animals legally taken may be bought or sold at any time. Unlawful to open or destroy a muskrat house or to place a trap at its entrance. Unlawful to dig skunks from dens or to drive them out by use of smoke or chemicals.

Open seasons.—Mink, otter, and muskrat, November 1 to May 1, except that in Addison County the open season for muskrat is during March and April only; marten, raccoon, fisher, and skunk, October 20 to April 1; for trapping foxes, October 20 to April 1 (foxes may be taken otherwise than by trapping at any time). No open season for beaver (1915, ch. 201).

Propagation.—The State fish and game commissioner issues special permits for propagating fur and game animals (fee, \$2 and expense of tagging). Animals bred on fur farms may be sold and transported alive at all times when bearing the identification tags prescribed by the commissioner (1915, ch. 231).

Bounties.—Bear, \$10; hedgehog (porcupine), 15 cents; paid by State (1912, ch. 207). Towns pay \$5 bounty on bay lynx or bobcat (1915, ch. 185).

VIRGINIA.

Trapping.—No State-wide regulations.

Open seasons.—No State-wide close season on fur animals.

Propagation.—No legal restrictions.

Bounties.—Boards of supervisors of counties may at their discretion pay bounties—not over \$10 for wolf; \$1.50 for wildcat, catamount, or red fox; and 75 cents for chicken hawk or owl (Code, sec. 834).

Local trapping regulations.—The following provisions are in force:

Culpeper County.—Unlawful in Jefferson magisterial district to trap foxes except in November and December. Traps set for foxes must be visited daily to release any dog that may be caught (1912, ch. 257).

Fauquier and Loudoun Counties.—Unlawful to take foxes April 1 to September 1, except by owner or tenant of land to protect property. Unlawful in open season to shoot, trap, or poison foxes except on written authority of a landowner (1914, ch. 141).

Halifax County.—Opossum, open season, October 15 to February 1 (1892, ch. 40).

Nansemond County.—Mink, otter, and muskrat, open season, January 1 to April 1 (1914, ch. 223).

Patrick County.—Wild raccoon or opossum, open season, October 15 to March 15; gray fox, September 15 to March 15 (1912, ch. 247).

Princess Anne County.—Unlawful to catch, trap, or kill mink, muskrat, or otter for profit, except from November 1 to March 15 (1910, ch. 191).

Rappahannock County.—Unlawful to trap or hunt on lands of another without written permit from owner (1910, ch. 361).

WASHINGTON.

Trapping.—No steel trap larger than No. 4 may be used unless a notice in the English language on a large placard is placed above the trap; this requirement does not apply to trapping coyotes (1915, ch. 151).

Open seasons.—No open season for beaver (R. & B. code 1910, sec. 5395). No close season for other fur animals.

Propagation.—No legal restrictions.

Bounties.—Mountain lion or cougar, \$20; lynx or wildcat, \$5; coyote, \$1; timber wolf, \$15 (1909, ch. 193); seal or sea lion, \$1 (1915, ch. 31); paid by State. Counties are permitted to pay additional rewards for destroying these animals, and also bounties on bear, muskrat, and squirrel (R. & B. code 1910, secs. 3587-3592).

WEST VIRGINIA.

Trapping.—Any owner of lands or his agent or tenant may hunt or kill protected fur animals on such lands at any time, but it is unlawful to set or maintain any snare or trap upon lands of another without the express permission of the owner or tenant. Unlawful to set any steel or spring bear trap on lands of another. Hunting license is required for trapping; fee, resident, \$3; nonresident, \$16.

Open seasons.—Red fox, raccoon, mink, and skunk, November 1 to January 1 (1915, ch. 14). Any county may by majority vote provide a perpetual close season on skunk (1903, ch. 44).

Propagation.—No restriction on possession or sale, but animals may not be taken for breeding purposes in close season except on lands owned or tenanted by the breeder.

Bounties.—Wildcat, bobcat, or catamount, \$5; crow, 10 cents; certain hawks and owls, 25 cents; paid from forest, game, and fish protection fund (1915, ch. 14).

WISCONSIN.

Trapping.—License is required for trapping; fee, resident \$1, nonresident, \$10. Unlawful to take fisher, marten, mink, or muskrat with the aid of spear, gun, or dog; to take rabbit with ferret; to disturb or molest muskrat houses, or beaver houses or beaver dams, or raccoon den trees for the purpose of capturing raccoons; or to set traps within 500 feet of any beaver dam or beaver house. Steel traps may be used for taking fur animals in open season. The possession of green skins of any fur-bearing animal during close season is unlawful, as is also the possession at any time of the skins of fisher, marten, mink, or muskrat showing that the same has been shot or speared.

Owners of cranberry marshes may at any time destroy muskrats to protect dams, but they may not sell, barter, or give away the skins of such animals killed during close season.

Beavers and otters are protected at all times. If beavers damage property, they may be captured and removed under the direction of the State conservation commission (1915, ch. 594).

Open seasons.—Fisher, marten, and mink, November 15 to March 16; raccoon, November 1 to February 2 (except in Washington and Ozaukee Counties, November 15 to December 16); muskrat,¹ November 15 to March 16. No open season for beaver or otter. Skunk, open season in Washington and Ozaukee Counties, October 10 to February 2; no close season in other parts of the State (1915, ch. 594, sec. 62.16).

Propagation.—Breeders of protected game or fur animals must obtain a license from the State conservation commission (fee, \$5) and make annual reports to the commission. The commission will furnish tags at cost of same to enable breeders to ship, sell, and transport animals or skins from their establishments (1915, ch. 594, sec. 62.51).

Bounties.—Wolf cub taken between March 1 and November 1, \$4; mature wolf killed at any time, \$10; wildcat or lynx, \$3; paid by county. County boards

¹ Exceptions, (1) in Lake St. Croix, Lake Pepin, Mississippi River, and all inland bays, bayous, and sloughs tributary thereto, the open season is March 1 to April 11; (2) in Polk, Barrow, Rusk, Prince, Lincoln, Langlade, Forest, Marinette, Florence, Oneida, Vilas, Iron, Ashland, Sawyer, Washburn, Burnett, Douglas, and Bayfield Counties the open season is November 1 to April 21.

may increase these rewards but no county may pay more than \$6 for killing a wolf cub. The State treasurer duplicates all county awards, thus doubling the above bounties. Poisons may be used for destroying animals for bounty between December 1 and March 1, but notice of putting out baits must be posted and they may not be placed within 80 rods of a dwelling house. County boards may offer bounty on crow, hawk, pocket gopher, streaked gopher, English sparrow, or rattlesnake (1915, ch. 594, secs. 62.47-62.49).

WYOMING.

Trapping.—Unlawful to trap game animals or birds or to use their flesh as trap bait for predatory animals. Unlawful to trap on State game preserves (1915, ch. 91),¹ and for anyone not employed by the United States Department of Agriculture to trap in national forests within the State without first obtaining a permit (fee, \$5) from the State game warden (C. S. 1910, Mullen, sec. 2786). Nonresident of State must secure a special license (fee, \$10) to hunt, pursue, trap, or kill bears (sec. 2748).

Open seasons.—No close season on fur-bearing animals except beavers, which may not be taken at any time until September 15, 1919, but if they damage real estate, the owner may obtain permit to destroy them (sec. 2769).

Propagation.—No legal restrictions.

Bounties.—Coyote, \$1.50; bobcat, \$1; adult male gray or black wolf, \$7.50 (female \$12, and positive proof of sex required); gray or black wolf pup, \$5; mountain lion, \$10; paid from State appropriations (1915, ch. 96).

ALBERTA.

Trapping.—Nonresident requires license to trap; fee, \$25. Unlawful to use poison for taking fur-bearing animals; to destroy, partially destroy, or leave open any muskrat or beaver house; or to destroy a beaver dam, unless authorized to do so by the lieutenant governor in council, who may also authorize the killing of beavers or other fur animals when such killing is deemed to be in the public interest. Export of unprime skins or pelts is forbidden, unless by permit from the minister of agriculture. No fox may be trapped or taken alive for export. Every company, firm, or person engaged in the fur trade must make annual returns of the numbers of skins bought or sold (game act, 1915).

Open seasons.—Mink, fisher, and marten, November 1 to April 1; otter and muskrat, November 1 to April 1. No open season for beaver until December 31, 1920, unless locally by order of the lieutenant governor in council (game act, 1915).

Propagation.—No restrictions on propagation, but export of live animals may be made only by permit from the minister of agriculture. The lieutenant governor in council may from time to time make additional regulations regarding buying, selling, and exporting game and fur-bearing animals reared on game or fur farms (game act, 1915).

Bounties.—The council of any rural municipality is authorized to offer a bounty on wolves.

BRITISH COLUMBIA.

Trapping.—License required to trap off one's own lands; fee, resident, \$10; nonresident, \$100. A licensed trapper who first occupies a trap line prior to November 14 is protected against other trappers. License must be returned within

¹ Five State game preserves are defined in a recent act (1915, ch. 105).

two months after it expires with a statement of number of fur animals of each kind taken. It is unlawful to touch or interfere with traps set by a licensed trapper, to trap on inclosed or cultivated land without permission of owner, or to permit traps to remain set after close of season. Export of pelts is allowed only during open season and for 60 days thereafter (1914, ch. 33). Special license (fee, \$25) is required by nonresident to hunt bears.

Open seasons.—All fur-bearing animals (fox, beaver, marten, fisher, mink, muskrat, otter, raccoon, and weasel or ermine), November 1 to April 1; except that beaver may not be taken on Vancouver Island or in streams running into the valley of the Okanogan, between Penticton and the International boundary line (order lieutenant governor in council, Aug. 16, 1915).

Propagation.—A permit to propagate fur-bearing animals is required. Breeder must keep a record of transactions as to purchases and sales of stock, which record must be open to inspection of any game warden (1914, ch. 33). Live foxes may be exported only under a permit; fee, \$100. Special license is required to take foxes or other fur animals in close season.

Bounties.—Rates fixed from time to time by lieutenant governor in council. Under regulations of October 7, 1914, they are as follows: Mature wolf or cougar, \$15; mature coyote, \$3 (half as much for young wolf, cougar, or coyote); golden eagle, in Yale, Kooteney, and Cariboo Counties, \$3.

MANITOBA.

[From "Game protection act," as amended to 1915.]

Trapping.—A license is required to trap, except on one's own land; fee, resident, 50 cents; nonresident Canadian citizen, \$25; nonresident alien, \$100. Report giving number of animals of each kind taken under license is required to be made before June 1. Nonresidents trading in furs must be licensed (fee, \$50) and are required to make annual returns before July 1. Residents of the Province trading north of the fifty-third parallel of latitude must take out license (fee, \$5). Unlawful to trap in Provincial game preserves, to trap on cultivated or inclosed lands without permission of owner, to destroy a muskrat or beaver house, to use poison in taking fur animals, or to export unprime skins. Poison may not be used to capture wolves for bounty.

Open seasons.—*South of fifty-third parallel:* Fisher, pekan, sable, and marten, November 1 to May 1; mink, otter, and beaver, November 1 to June 1; muskrat, October 20 to June 1; fox and lynx, November 1 to April 1. *North of fifty-third parallel:* Fisher, pekan, sable, and marten, November 1 to May 1; mink, otter, and beaver, November 1 to June 1; muskrat, October 20 to June 1; fox and lynx, November 1 to April 1.

Propagation.—No legal restrictions, except that special permit is required to export a live fox from the Province; fee, for black or silver fox, \$100; for cross or red fox, \$15.

Bounties.—Timber wolf, \$5; other wolf, \$2; half is refunded to municipality by the Provincial treasurer (1915, ch. 95).

NEW BRUNSWICK.

[From "Game act of 1909," as amended to 1914.]

Trapping.—Nonresidents require a license (fee, \$25) for trapping. A license is also required to deal in, buy, sell, cure, or tan the skins of fur-bearing animals. The digging out of foxes from their homes or earth burrows is prohibited at all times. Unlawful to possess green skins or carcasses of protected fur animals in close season.

Open seasons.—Mink, otter, and fisher, November 1 to April 1; fox, October 1 to March 1; muskrat, noon of March 25 to noon of May 15. Marten or sable, close season to July 1, 1916; beaver, close season to July 1, 1917. The surveyor general, when satisfied that a number of beavers may be taken from any stream without injury to the supply, may issue a special license for taking them; fee, \$2 for each animal taken.

Propagation.—Permits to capture wild fur-bearing animals for propagation within the Province may be obtained from the surveyor general, who fixes the fee for such permit.

Bounties.—Wildcat (killed within the Province), \$1, paid by the surveyor general.

NEWFOUNDLAND.

[From game laws of Newfoundland, 1913, corrected to 1915.]

Trapping.—Nonresident trappers require annual license; fee, \$501. Fur buyers and shippers also require annual license (fee, 50 cents), and must report operations under same before December 31 of each year. Trapping on Grand Lake Caribou Preserve is unlawful at all times.

Open seasons.—Otter, marten, and lynx, October 1 to April 1; fox, October 15 to March 15; muskrat, October 1 to May 1. No open season for beaver until October 1, 1918.

Propagation.—No restrictions, except as to foxes. A fox farm must be licensed; the owner must at stated times make reports to the game and inland fisheries board, and the premises must be at all times open to inspection by officers of the board. Possession of fox cub or fox taken in close season is prohibited. Unlawful to export a fox not bred on a fox farm, or without permit from the Colonial board to export a fox bred in captivity.

Bounties.—None paid.

NORTHWEST TERRITORY.

Trapping.—Use of poison prohibited in taking fur-bearing animals. Export of low-grade furs forbidden (1903, 2d sess., ch. 29).

Open seasons.—Mink, fisher, and marten, November 1 to May 15; otter, beaver, and muskrat, October 1 to May 15.

Propagation.—No legal restrictions.

Bounties.—None paid.

NOVA SCOTIA.

Trapping.—Nonresident requires a license (fee, \$30) to take fur-bearing animals, which are included in the term "game." Unlawful to take any protected fur animal from a burrow or den by smoking, digging, or by use of poison; to damage or molest a beaver dam or house, or a muskrat house, or set snare or trap within 25 feet of the latter; or to have in possession the green hide or pelt of a fur animal taken out of season (1915, ch. 38).

Open seasons.—Mink, otter, fox, raccoon, and muskrat, November 1 to February 1; all other fur-bearing animals (except bear, wolf, and wildcat, which are not protected), November 1 to February 1. No open season for beaver or marten (1915, ch. 38).

Propagation.—Permits to take wild animals may be obtained from the board of game commissioners under such restrictions as they may require. Unlawful to keep fur-bearing animals in captivity for breeding purposes without a permit from the chief game commissioner; fee \$2 for each kind of ani-

mal kept, payable annually. Reports are required annually on September 30. Inclosures for fur animals are protected from trespass (1912, ch. 59).

Bounties.—None paid.

ONTARIO.

[From Rev. Stat., ch. 262, as amended to 1915.]

Trapping.—Trapping license (fee, \$50) is required of nonresidents. License (fee, \$2) is required of all fur dealers or traders. Dealers may obtain a permit to hold raw furs during close season. Muskrats may not be shot during April nor speared at any time. Muskrat houses are protected at all times except when the animals are injuring property. Beavers, when damaging property, may be destroyed by game overseer under special authorization from the superintendent of game fisheries.

Open seasons.—Mink, November 1 to May 1; muskrat, December 1 to May 1 (except that in Port Arthur, Fort William, Rainy Lake, and Kenora electoral districts it is during March and April only). Beaver and otter are protected to November 1, 1916, after which date hunting, taking, or killing them shall be permitted only during such periods and on such terms and conditions as may be prescribed by the lieutenant governor in council (1915, ch. 20).

Propagation.—A permit is required of breeders of game or fur animals. Licensed fur breeders may sell live animals or skins at any time.

Bounties.—Wolf, \$15; paid by county; but Provincial treasurer refunds \$8 (1911, ch. 77).

PRINCE EDWARD ISLAND.

Trapping.—Nonresident requires license (fee, \$50) for trapping. Unlawful to put out poisoned baits for foxes or other animals.

Open seasons.—Marten, mink, muskrat, and otter, November 1 to April 1.

Propagation.—Several special acts of the Provincial legislature regulate fox ranching on the island. The animals are assessed for taxation (1913, ch. 9) and ranches are protected from trespass, under heavy penalties (1913, ch. 10).

Bounties.—None paid.

QUEBEC.

[From Rev. Stat. 1909, ch. 8, as amended to 1914.]

Trapping.—Reports are required of all persons engaged in the fur trade (buying, selling, or taking fur animals) within the first 15 days of May of each year.

Open seasons.—*Zone No. 1* (west and south of Saguenay River): Mink, otter, marten, pekan (fisher), fox, and raccoon, November 1 to April 1; bear, August 20 to July 1; muskrat, during April only. Beaver, protected to November 1, 1917; open season thereafter, November 1 to April 1. *Zone No. 2* (east and north of Saguenay River): Mink, marten, and pekan, November 1 to April 1; bear, August 20 to July 1; muskrat, November 1 to April 1; otter, October 15 to April 15; beaver, November 1 to April 1, except in Chicoutimi County, where close season extends to November 1, 1917.

Propagation.—The minister of colonization, mines, and fisheries may grant permits to take animals alive for breeding purposes; nonresidents are charged a fee of from \$5 to \$25 for such license.

Bounties.—Wolf, \$15.

SASKATCHEWAN.

[From Rev. Stat. 1909, as amended to 1915.]

Trapping.—Nonresident requires license (fee, \$25) to trap. Unlawful to trap on game refuges; to use poison for taking fur animals; to spear or shoot muskrats, or to destroy muskrat house or beaver dam; to export unprime furs; to buy or sell furs without license (fee, 60 cents); and to ship any fur animal in concealed receptacle. Licensed fur traders must make annual report of operations.

Open seasons.—Mink, fisher, and marten, November 1 to April 1; otter and muskrat, November 1 to May 1; fox, September 1 to May 1. No open season for beaver until January 1, 1920.

Propagation.—No legal restrictions, except as to shipping live foxes and capturing young foxes for breeding purposes. Permit to ship is required; fee, for black or silver fox, \$25; for cross or red fox, \$5. Young foxes may not be taken from dens before May 15.

Bounties.—Timber wolf, \$5 (pup, \$1); prairie wolf, or coyote, \$1; paid only in properly gazetted wolf districts, when half is refunded from provincial treasury (1907, ch. 28).

YUKON TERRITORY.

Trapping.—Use of poison in taking animals forbidden.

Open seasons.—No close season except for young foxes; these may not be taken from April 1 to June 1.

Propagation.—No restrictions other than as to foxes. Registration of fox breeders required. Unlawful to export a fox not born in captivity or which has been in captivity for less than a year; any fox born in captivity may be exported under a permit (fee, \$5). Fox and other fur ranches, if posted against trespass, may not be approached without owner's consent.

Bounties.—None paid.



UNITED STATES DEPARTMENT OF AGRICULTURE



FARMERS' BULLETIN

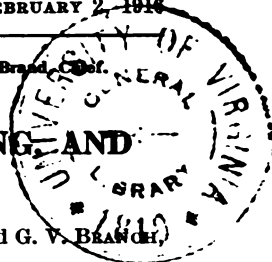


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Contribution from the Office of Markets and Rural Organization, Charles J. Brand, Chief.



THE COMMERCIAL GRADING, PACKING, AND SHIPPING OF CANTALOUPE.

By C. T. MORE, *Investigator in Market Grades and Standards*, and G. V. BRANCH,
Investigator in City Marketing.

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INTRODUCTION.

Experienced produce merchants will agree with the statement that any fruit or vegetable of desirable variety, well grown, carefully harvested, properly graded, packed, and shipped, is more than half sold. On the contrary, products poorly grown or carelessly prepared for market are always disposed of under a decided handicap.

The appearance of an article of fruit or produce is the first point noticed by the consumer, the retailer, or the wholesaler. If the product is exhibited in dirty or damaged packages; if it is slack-packed, decayed, or not graded for size or quality, the best "trade" will pass it by for other shipments of better appearance. If upon further inspection the eating or keeping qualities are found to be lacking, the article is sure to be rejected by the discriminating buyer.

NOTE.—This bulletin should be of interest to the commercial growers and shippers of cantaloupes in all sections of the United States.

Years of observation on the part of those closely connected with the business warrant the statement that markets are rarely glutted with fruits or vegetables of first-class quality and appearance. High-grade products will sell, and usually at a profit to the grower, even when ordinary or poor grades are going to waste. This situation is to be expected since it is natural for both dealers and consumers to want the best. On a normal market the higher grades may be out of reach of many on account of the price, but when a market is glutted and the quotations drop, the "trade" will become more and more discriminating. The well-graded and well-packed produce will be taken and the mediocre stock left or sold at a sacrifice. Wholesalers and retailers know that the higher the quality of their goods, the less the chance of loss in deterioration, time, and customers.

A PRODUCT OF BETTER QUALITY NEEDED.

That consumption is retarded by the shipping of undesirable produce was again proven conclusively during the year 1914. Early in the California shipping season a large number of cars of cantaloupes were picked when too green and rushed to the eastern markets in order that advantage might be taken of the high prices prevailing at that time. The result was that after buying two or three lots of these undesirable melons, consumers not only complained to the retailers, but stopped buying cantaloupes and turned to more desirable fruits, which were both plentiful and cheap. Many of these consumers probably did not buy cantaloupes again until they were able to secure home-grown stock. Every grower and shipper of highly perishable products should realize that when profits accrue from his business, they generally are due to the marketing of produce of good quality and appearance. In certain years of scarcity poor products may be disposed of at a profit, but in the great majority of cases they are a source of loss to all persons engaged in handling them.

This bulletin is designed to aid growers and shippers in preparing their cantaloupes for market in such a way that they may realize higher average returns with fewer losses.

The statements made herein are not based on extensive experiments conducted by the Department of Agriculture, but rather are results of careful observations of grading, packing, and shipping operations as now conducted by the most progressive growers and shippers in some of the best commercial cantaloupe sections of the country, supplemented by investigations of cantaloupe-marketing conditions in many of the larger cities. Studies along this line which may be conducted in the future may develop still more practical and efficient

methods than are here outlined, but the immediate need for some guiding information on the subjects mentioned is so apparent that a recount of the best methods now in use should be of help to a large number of growers.

Growers should bear in mind from the start that it is advisable to produce melons of good quality in order to succeed. A comparatively few years ago the season for eating cantaloupes in the average city was from a month to six weeks in duration. As the demand for the product was strong and the supply light, it was not necessary for growers to place such high-class fruit on the market. Now, however, in almost any of the larger markets the cantaloupe season extends at least from June 15 to October 1, and the generous supplies, together with a more discriminating appetite on the part of consumers, make quality of high degree a necessary factor in success-

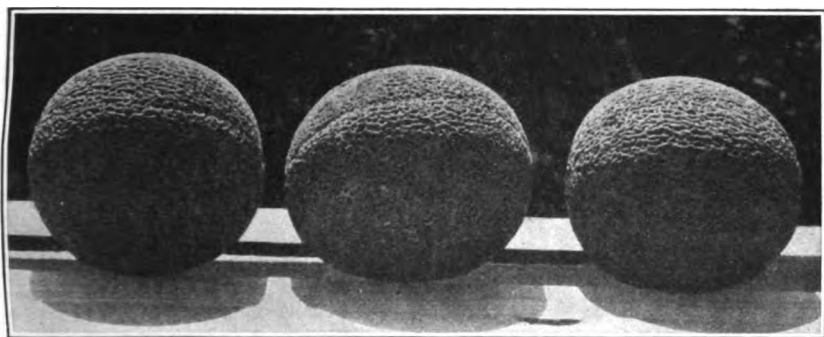


FIG. 1.—Three well-netted cantaloupes. A sample of exceptionally fine commercial stock.

ful marketing. It is not realized generally by cantaloupe growers to what extent the commercial production of this fruit has advanced during the last 10 years. The shipments from the Imperial Valley of California alone have increased about 1,500 per cent during this time, as shown by the following table:

Increase in shipments of cantaloupes from Imperial Valley, 1905-1914.

	Carloads.		Carloads.
1905.....	297	1910.....	1, 621
1906.....	577	1911.....	2, 580
1907.....	644	1912.....	2, 887
1908.....	1, 891	1913.....	3, 502
1909.....	1, 411	1914.....	4, 480

While this growth is hardly typical of the production in commercial growing sections of other States, growers, especially those in the West, should appreciate the fact that the Eastern and South-

ern States are producing now not only thousands of carloads of melons, but that they are continually improving the quality.

When compared with the moderate expense and short time required to market fruit from many producing sections in the East, western growers are greatly handicapped by high transportation and refrigeration costs and the length of time necessary to reach the consumer. Therefore it is the more important that they grow the best stock possible. From Laurel, Del., for example, cantaloupes picked, packed, and loaded Monday morning, between daylight and about 9 o'clock, when the through freight goes north, are for sale on the New

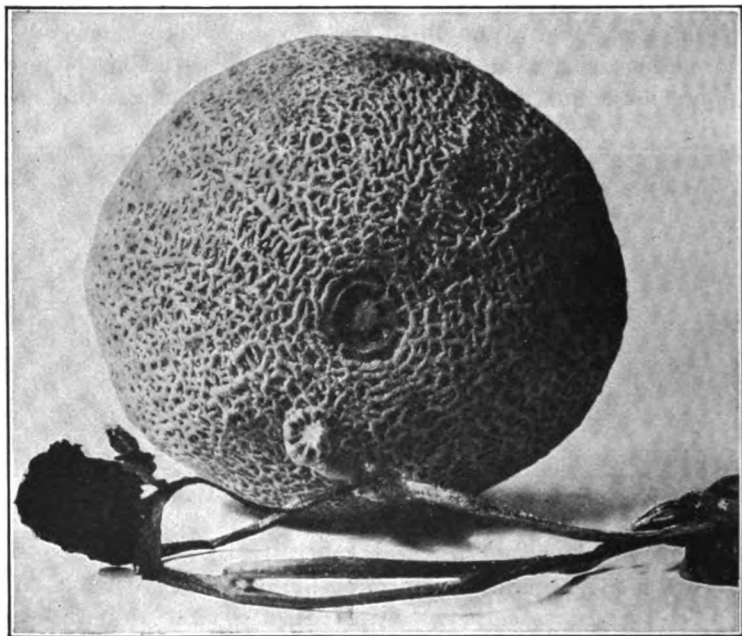


FIG. 2.—An illustration of the term "full slip" used in picking cantaloupes. Note how the stem pulls away from the melon, leaving a clean, cuplike hole.

York market Tuesday morning. The freight rate is about $12\frac{1}{2}$ cents a crate and no refrigeration is required for shipments made on this train. Cantaloupes picked and shipped at Ordway, Colo., however, are not on sale in New York until about seven days later and the freight, plus refrigeration, is \$1.17 per 100 pounds, or approximately 79 cents for a standard crate.

Since the crop now is grown so generally and the competition on the markets has increased, it behooves each planter to secure seed which will produce in his section melons of the very best eating and shipping qualities, and then give the crop the best of care until it reaches maturity.

PICKING AND HANDLING CANTALOUPE.

The proper picking of cantaloupes is a most important operation in preparing them for market. The best judgment must be exercised in selecting melons which have reached the right stage of maturity to carry properly, and experience on the part of pickers and inspectors is necessary if good results are to be obtained. As a matter of fact, it is difficult to make a rule that will state just when they should be picked, for so much depends on such things as the distance from market, the varieties grown, and seasonal conditions. Directions

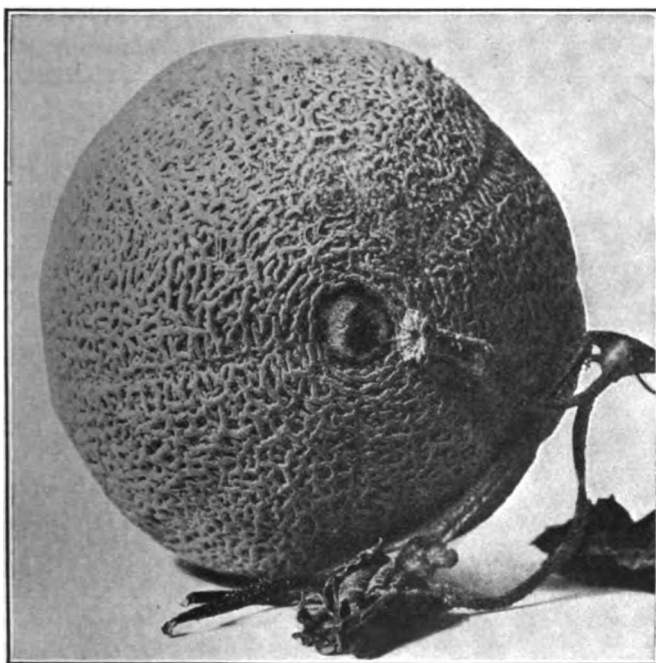


FIG. 3.—A cantaloupe picked on "half slip." Only a part of the stem has "slipped" from the melon easily, leaving the depression on the right side, the other part having broken. As a rule, this condition signifies a less degree of ripeness than the "full slip."

that apply in one section will not necessarily hold good in another. It may be said, however, that melons of the "Netted Gem" strain commonly referred to as "green meats" should be completely netted (fig. 1) before they are harvested. The netting also should be developed fully, that is, well raised up and rounded out on the surface. The netting of immature melons is flat and creased on the top, this crease filling up as the fruit ripens. The dull-green background which shows through the openings in the netting should be developing a lighter shade, and when the shipping distance is short the melons may be left on the vine until this green skin shows a tinge of yellow. Canta-

loupes should not be cut from the vine nor picked when so green that the vine will break off a short distance from the melon. They must be picked every day to avoid overripe stock, and in some cases best growers go over the vines twice a day when the weather is unusually hot.

For shipping short and medium distances most cantaloupes can be picked on what is known as a "full slip," that is, just as soon as the stem will separate from the melon cleanly under moderate pressure of the thumb or finger, leaving a cuplike hole and taking with it none of the rind (fig. 2). At the beginning of the shipping season, when both vines and fruit are vigorous, it is generally possible to ship "full slip" melons much longer distances than is practicable at a later



FIG. 4.—Mexican pickers in a field of Colorado "pink meats." Note the type of picking sack used. It may be lowered into a receptacle, the lower end opened, and the sack withdrawn, thus depositing the melons with little possibility of being bruised.

period. In the Imperial Valley of California, for instance, nearly all of the large distributors now insist that the Japanese growers pick only on the full slip for several days at the opening of harvest, in spite of the fact that the fruit is designed for the eastern markets.

Except as above noted, it usually is necessary when shipping long distances to pick on a "half slip," in which case only part of the stem pulls away from the melon smoothly, the rest breaking (fig. 3). It is claimed that certain recently developed varieties may be picked at "full slip" throughout the season and still carry long distances successfully. If this is true, these varieties have a great advantage over those which must be picked greener, since the "full slip" melons, as a rule, have a much better flavor than others.

Colorado, Georgia, Arkansas, and a few other States produce large quantities of "pink meats," of which the "Burrell Gem" is the most extensively grown commercial variety for long-distance shipping and the one referred to in this bulletin when the term "pink meat" is used. It is more difficult to determine just when these melons have reached the proper stage of maturity for shipping, and in picking them more dependence is placed on the shade of the green rind which shows in the sectors and through the thin netting than in the case of green-meated melons.



FIG. 5.—Cantaloupes hauled from the field to the packing house in hampers.



FIG. 6.—A cantaloupe packing bench under trees. Melons have been hauled from the pickers to the packing bench in large burlap bags—not a commendable practice.

Pickers can further familiarize themselves with the condition of the stock in the field by cutting a few specimens occasionally to ascertain the degree of sweetness of the flesh and whether it has begun

to soften. The color of the seeds and flesh is also a good indication of the stage of maturity, but as this varies somewhat with different varieties and under different conditions, no exact description can be given.

Regardless of what method is used to determine when melons are ready to pick, it is recommended urgently that growers and shippers of all sections ascertain the condition of their fruit on arrival, either by accompanying to their principal markets shipments picked at various stages of ripeness, or by obtaining from their receivers on the markets a report on this condition. With this knowledge the grower subsequently can pick his cantaloupes when they have reached the stage of maturity at which they will be most likely to reach the consumer in satisfactory eating condition. This is emphasized as

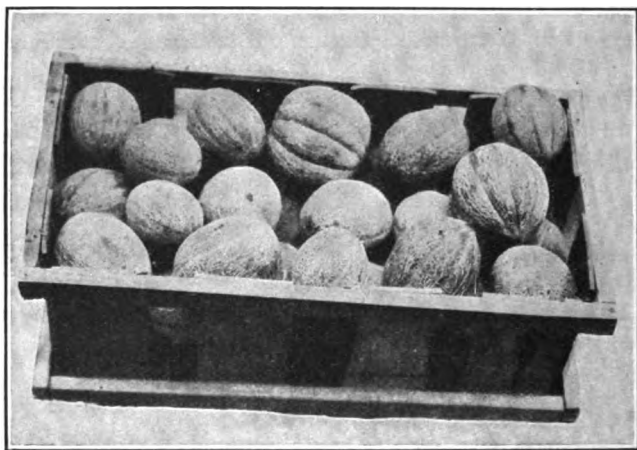


FIG. 7.—A crate of cantaloupes from the southeastern section of Virginia. Note the unattractive jumble pack of melons, ungraded as to size, variety, or quality.

a vital part of cantaloupe marketing because of the large percentage of green or overripe cantaloupes found on nearly every market.

It is important that melons be handled carefully throughout their journey from field to consumer. The illustration (fig. 4) on page 6 shows the cantaloupe-picking sack used quite extensively in the West. It is carried suspended from the shoulders. Such a sack can be emptied into crates easily without bruising the melons, as it simply is lowered into the crate, the bottom opened, and the sack withdrawn. In some sections "standard" cantaloupe crates are used in picking, while in others round, half-bushel baskets are found satisfactory.

The "standard" cantaloupe crate is usually employed to convey the melons from the field to the packing shed. Hampers (fig. 5) and baskets are used in some places and occasionally the melons are

hauled in the picking sacks, although this method is hardly practicable. Care should be exercised in hauling; handling in large burlap bags (fig. 6) or loose in the wagon box is not advisable as there is too great a chance for the stock to become bruised. At the packing shed the melons should not be dumped or thrown carelessly into the bins on the packing bench.

SHIPPING PACKAGES.

The crate generally used for cantaloupes is made of two heads or ends, 12 inches square, and twelve slats $23\frac{1}{2}$ to 24 inches long, according to the type of head used. It is known as the "standard" cantaloupe crate, being the one in which the bulk of the crop is shipped from California, New Mexico, Florida, Utah, Colorado, Texas, Georgia, the Carolinas, Delaware, Maryland, and several other States. The western "jumbo" crate measures 13 by 13 by $23\frac{1}{2}$ inches and the "pony" crate 11 by 11 by $23\frac{1}{2}$ inches. The pony and jumbo crates are used much less than the standard. In seasons of heavy production, the small melons packed in the pony crates

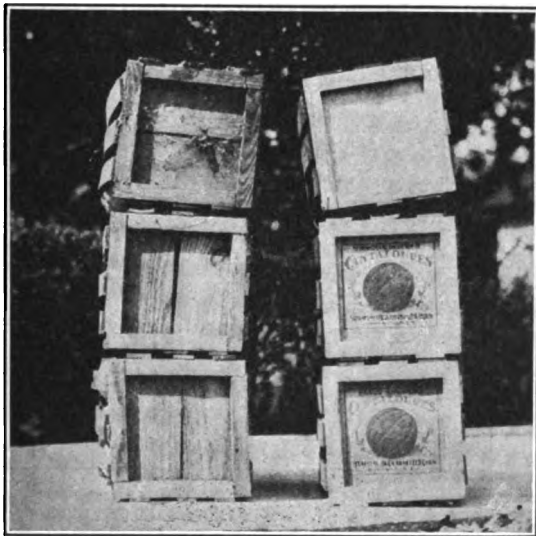


FIG. 8.—Three crates, old and dirty, contrasted with three new and attractively labeled ones.

often can not be shipped profitably, while many sections are finding it more desirable to pack their jumbo melons in the standard crates.

A "two-thirds" crate, which measures 8 by 12 by $23\frac{1}{2}$ inches, is occasionally used in some sections, and the "two-thirds jumbo" crate is still employed extensively in the shipment of the Arizona crop. However, the former is nearly obsolete now and the latter is losing in favor in most markets, as it fills no particular need and adds to the undesirable multiplicity of cantaloupe packages.

The three types of crates used in Colorado for the elongated, pink-meat melons are the "standard flat" ($4\frac{1}{2}$ by 13 by 23 inches), the "jumbo flat" (5 by $14\frac{1}{2}$ by 23 inches), and the "pony flat" (4 by 12 by 23 inches). This type of cantaloupe is seldom packed in other than flat crates. The comparatively few flats used for the

shipment of green-meated melons in this State are of the same depth and width as the pink-meat flats, but exceed them in length by one-half inch.

Delaware standard crates measure 12 by 12 by 24 inches, pony crates 11 by 11 by 24 inches, and jumbo crates 14 by 14 by 26 inches. In the Decker cantaloupe section of Indiana the regular standard crate (12 by 12 by 24 inches) is used, but the flats employed are of two lengths, the popular one being $4\frac{1}{2}$ by 12 by 20 inches and the one less used $4\frac{1}{2}$ by 12 by 24 inches.

Several of the smaller cantaloupe-shipping sections are still using containers of odd size and construction—a practice which is detrimental to the business in general and probably a source of actual loss to the shipping sections. In the Norfolk section of Virginia jumble-packed cantaloupes are shipped in large crates, 15 by 18 $\frac{1}{4}$ by

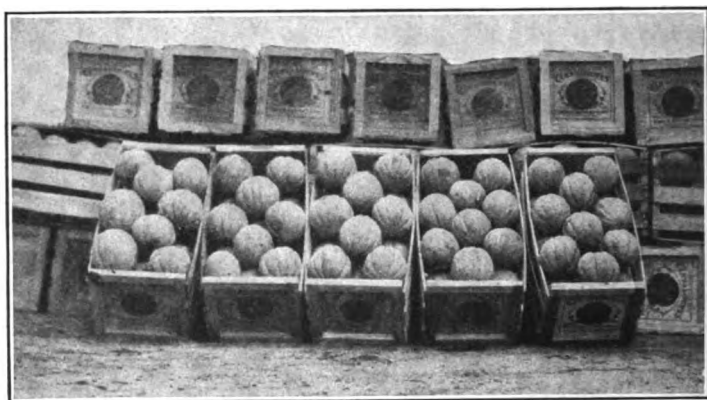


FIG. 9.—Standard crates packed with jumbo-sized cantaloupes, 23 and 27 to the crate.

30 inches in size, of the same type as their 60-quart strawberry crate. These are used for the larger varieties, such as the "Emerald Gem," "Black Jap," and "Osage." This section also packs in smaller crates of similar design (fig. 7), measuring $10\frac{1}{2}$ by $12\frac{1}{2}$ by 25 inches, which carry the smaller melons of the "Knight" and "Rocky Ford" types.

In some of the Central States, particularly Illinois, Indiana, and Michigan, in addition to using the standard crate, a part of the cantaloupe crop is marketed in "Climax" and other baskets, as well as in short, flat crates and boxes holding 10 to 16 melons. On account of the small capacity of the Climax basket it is difficult to maintain an even-sized run of melons, and too often the bottom layer of fruit in this package is found to be much inferior in quality and very loosely packed when compared with the top layer.

It can be seen readily that in shipping cantaloupes, as in shipping most other perishable crops, too many types of packages are used.

However, there is a gratifying tendency on the part of many cantaloupe-producing areas to discard the odd styles of containers and unite in the use of the standard crate and the standard flat. This is evidenced by the fact that whereas formerly in the Decker cantaloupe section of Indiana a large part of the crop was shipped in $\frac{1}{2}$ -bushel "Climax" baskets, during the season of 1914 it is estimated that not more than 10 per cent of the melons shipped were so packed, the rest going out in the standard crate and the flat.

The appearance of the cantaloupe crate plays such an important part in the marketing of the product that shippers should always pack in first-class containers. Crates should be well made, of clean, smooth, strong lumber with all cross-grained or knotty slats discarded, since they are liable to break before reaching the retailer, with the result that melons become bruised or lost. Dirty crates (fig. 8) and secondhand crates must never be used if top market prices are expected. Crates used in the field in harvesting operations should not be utilized for shipping packages.

In opening a car of cantaloupes after arrival in the market it is the rule, rather than the exception, to find several crates with broken or loosened slats. In the work of distributing the cantaloupes to jobbers and retailers throughout a city, many more crates burst open. Broken crates mean melons injured, stolen, or lost. While rough handling is doubtless a contributory cause, insecure nailing is responsible for a great deal of the trouble. It is the consensus of opinion that the use of cement-coated nails aids greatly in keeping the crates intact, and there is little doubt that the lessened breakage will more than offset the small increase in cost.

GRADING CANTALOUPE.

Too little attention is given grading operations by the owners themselves, that work being left largely to hired help. There seem to be no uniform and specific grading rules in use in cantaloupe-shipping sections, and as a result the troubles which arise from the lack of standardization are very apparent. It would be advisable for shippers in each section to agree on the standards of quality and the grading rules to be observed. These should be printed on large cards to be furnished to all persons connected with the harvesting, grading, and packing operations and should be posted in conspicuous places about the packing houses.

In some of the more carefully managed packing houses, sorters, or the packers acting in that capacity, grade a binful of cantaloupes for quality and appearance before the packing is done. Occasionally these sorters also grade for size, but it is a general custom in many commercial growing sections for the packer to grade the cantaloupes

as he packs, throwing out the culls as he finds them and picking out melons of the size that he wants to use. This is not the method employed in the most successful packing of other highly perishable products and it doubtless is a poor one to use in packing cantaloupes.

Even though no uniform grading rules are observed, growers in any section who desire to place their stock on the market in good, salable condition should see to it that all poorly netted melons, commonly known as "slickers," are thrown out, as well as the cracked, diseased, ill-shapen, overripe, or immature specimens, and those having soft ends. Melons which have been cut or bruised by sticks, nails, or stones should be discarded, as they are likely to spoil before reaching the consumer. Only first-class, merchantable cantaloupes should be packed. Fully ripe stock, if shipped, invariably should be

handled separately and sent only to near-by markets. Further suggestions on possible improvements in grading are taken up later.

PACKING CANTALOUPEs.

It is of great importance that the cantaloupes in each type of crate be of uniform size, since large and small melons packed together constitute an undesirable package, which not only makes a very poor appearance on the market, but is discriminated against by retail buyers because of the fact that the melons contained



FIG. 10.—Two exceptionally well-packed standard crates of cantaloupes. Upper crate pictures the standard 45-pack. Lower crate shows the 36-pack, known in Colorado as "Special." Note the heavy netting on these cantaloupes and the uniformity in size and shape.

therein can not all be sold at the same price. Restaurants, hotel dining rooms, railway dining cars, and similar institutions require melons of uniform size as trade demands make it desirable for them to serve every patron with equal portions.

Standard crates should contain 45 melons; pony crates 54 or sometimes 45; and jumbo crates, 36 or 45, according to the size of the fruit. Many sections of the country do not use the jumbo crate, but put up a "jumbo pack" in the standard crate (fig. 9). This usually consists of 36, 33, 27, or 23 cantaloupes, according to their size, but, as a rule, the pack is 36. In Colorado standard crates packed with 36 melons are known as "specials" (fig. 10, lower crate).

The five melons in each row of "standard 45's" (fig. 10, upper crate) ought to fill exactly the length of the crate and should be packed only end to end—never placed in the row sideways "just to make them fit." When the crate is full, three rows wide and three deep, every melon on each side should touch the slats, and the crate, when covered, should bulge slightly on all sides. If the packer does not secure this bulge, then the crate probably will arrive on the market "slack-packed," with the melons loose or the pack jumbled (crates at left of fig. 11). In either case the market value is reduced.

The "pony pack" of 45 melons to the crate is the same as the "standard pack" of 45. The "pony pack" of 54 is similar to the 45 pack, except that 6 melons are placed in each row instead of 5.

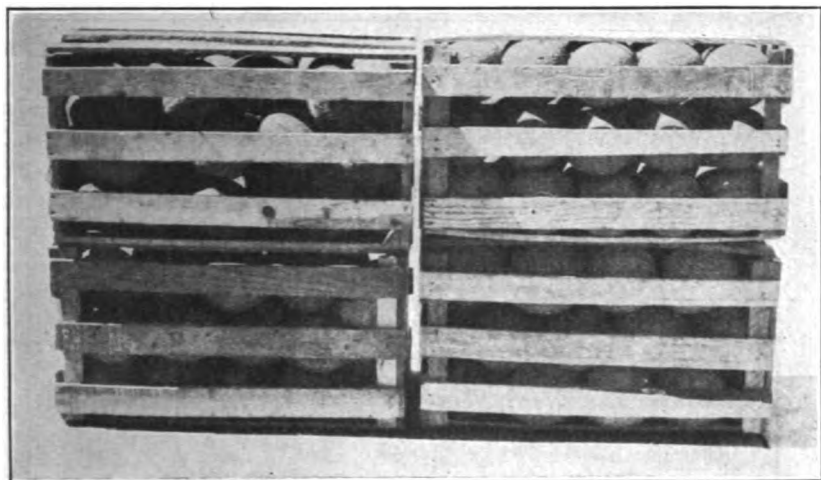


FIG. 11.—The two crates at the left show how poorly packed cantaloupes arrive on the market. On the right are two attractive crates in good condition due to the proper grading and packing of the cantaloupes at shipping point. On a glutted market the crates at the right were selling at a profit, while the ones on the left would not bring freight charges.

The jumbo crate, containing 45 cantaloupes, is packed in the same manner as the standard, the only difference being that the melons are larger. Often the melons run so large that only 36 can be packed in this jumbo crate, in which case the rows are four melons long and are packed diagonally, as shown in the lower crate of figure 10.

All that has been said about grading the green-meat melons applies with equal force to the longer "Burrell Gems." The latter, however, are packed somewhat differently. On account of the shape of these melons they should not lie flat in the crate, but rather at an angle, so that the end overlaps the adjoining melon, as shown in the crate in figure 12. As a rule, they are not so attractive in appearance as the more heavily netted ones and consequently are generally

wrapped. This wrapping should be neatly done and the melons so packed that the corners of the paper do not show at the edges of the crate in an unsightly manner. All the printing on these wrappers should be turned toward the top of the crate.

It is desirable to produce and ship pink meats which are well netted over the blossom end as shown at the left of figure 12. Those on the right of the picture are poorly netted.

From the foregoing it will be seen that, under the methods practiced in many cantaloupe sections, the person who does the packing is also responsible for the grading, sizing, and wrapping (where wrapping is done). As he is usually paid by the crate for his work, it is obvious that he wishes to pack the greatest number of crates possible each day. Therefore, results are not likely to be satisfactory.

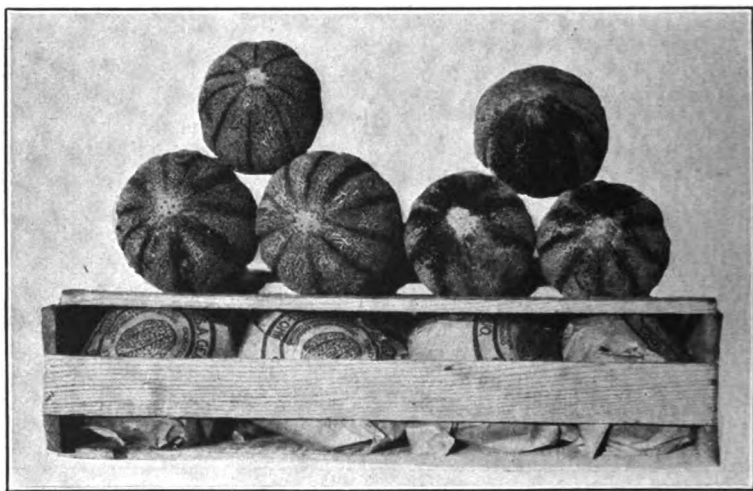


FIG. 12.—Above at the left, three Colorado "pink meats" well netted over the ends; at the right, three melons that are poorly netted or "slick." Below, a standard flat of wrapped "pink meats."

TYPES OF PACKING SHEDS.

Figures 6, 13, and 14 give an idea of the average packing facilities now used. In many sections the cantaloupe bins or packing benches are placed out in the field and if possible in the shade of trees (fig. 6). In other places, sheds are built. In Colorado the packing is done mostly under brush-roofed packing sheds, located in the field (fig. 13). The packing house shown in figure 14 is that of a large North Carolina grower and shipper. This house is not only commodious and substantial, but convenient, as well. The teams bringing cantaloupes from the field drive through it and the melons are emptied from the containers on the wagon directly into the bins on the packing benches. It will be noticed that back of the packers is a platform on which to

stack the crated melons in the shade until they are hauled to the cars. When cantaloupe-harvesting operations are not in progress, this packing house is used as a storehouse for farm machinery.

The bins holding the melons slope toward the packer and are built just high enough to allow him to reach the cantaloupes easily and pack standing upright. Figure 15 shows the manner of packing, with the crate tipped toward the packer and placed by the side of the bin of cantaloupes. The work of packing is simplified by having the crate in this slanting position as the melons will remain where they are placed and not roll about.



FIG. 13.—Type of brush-roofed packing shed used in the Ordway and Rocky Ford sections of Colorado. Note cull pile at the left.

PRESENT METHODS OF INSPECTION.

In many sections east of the Mississippi melons are packed, hauled, loaded, and shipped without inspection. In the West cantaloupes are inspected more or less carefully at the platform or car door before being loaded (fig. 16). However, in the case of wrapped melons this is an unsatisfactory method, for the inspector can tell but little regarding the color and netting when they are covered entirely by paper. Better work can be done when the product is unwrapped, but even then such a system of inspection does not accomplish all that is desirable. In the larger crates it is impossible to see or feel of all the melons and much imperfect stock often escapes notice. Even when crates are found to hold defective fruit it is difficult to accomplish proper repacking at the loading platform, and, unless the poor specimens are plainly noticeable, many inspectors will pass the lot rather than reject it and run the risk of antagonizing the grower.

Recently in some of these western sections field and packing-house inspection has been practiced to some extent in addition to that at the loading shed, and generally with satisfactory results.

NEED OF BETTER GRADING, PACKING, AND INSPECTION.

In all sections and on every crop about one-half of the marketing troubles appear to be concerned with the problem of securing a steady and properly prepared output of uniform grade, quality, and appearance. It would not be difficult to obtain such results if all the individual growers in a community produced crops of the same variety and quality, handled them in the same way, and were both competent and willing to grade and pack them correctly. However, such conditions are very rarely found. Too often growers ship cantaloupes which they acknowledge are not of desirable quality—fruit which they themselves would not eat. If growers

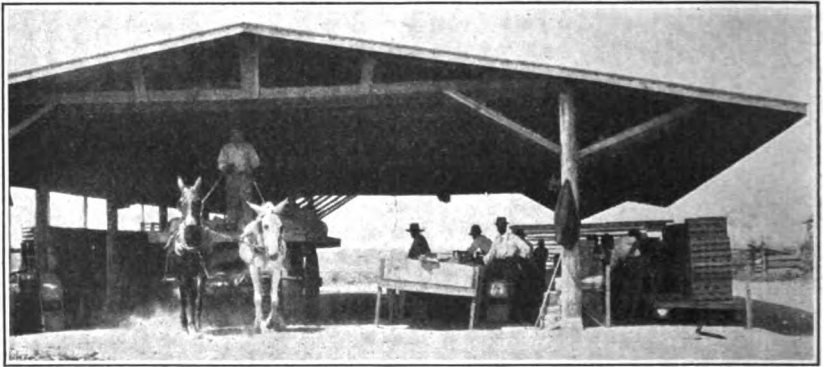


FIG. 14.—Substantial packing shed of a large grower in North Carolina. When not used for packing, this shed houses farm machinery.

of this type can get their poor product past the inspector or conceal it in a car under stock of better appearance, they feel that they have profited. Unfortunately, this does not end the case. The wholesaler will have difficulty in disposing of the poor melons, while the retailer, in turn, probably will lose on them. If they reach the housewife she will throw them away and turn to other fruits, thus decreasing the future sale of cantaloupes.

Again, a crate of poor fruit may go to a restaurant, hotel, or dining car, where it is necessary to cut several of the cantaloupes before finding one satisfactory to serve. Incidentally, such conditions constitute a valid reason for the high price of melons on the average bill of fare. In all these cases the grower eventually loses, directly or indirectly. If the actual loss in money is not deducted from his net returns, he suffers by the injury done his reputation and that of his growing section.

At first thought it would seem reasonable to expect the local buyers, shippers, solicitors, and distributors to eliminate such practices, but there is, as a rule, so much competition among them that they do not accomplish the reforms which, individually, they know to be desirable.

These various weaknesses in the methods now in general use, which are preventing a much-needed improvement in marketing cantaloupes, argue for a more efficient system of grading, packing, and inspecting this product.

It is quite evident that the inspection of the fruit should take place at the packing house, and it is of still more importance that the grading should be done before the melons go to the packer. Grading

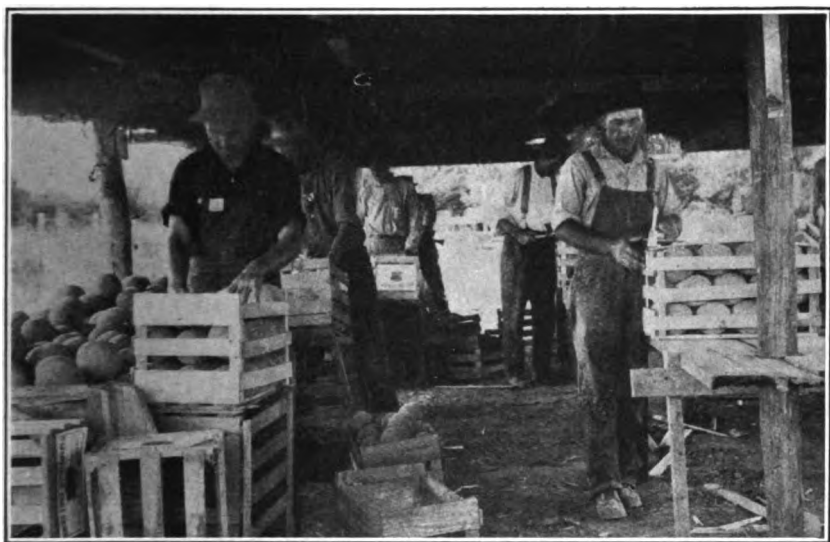


FIG. 15.—Interior of a packing shed at Rocky Ford, Colo. The crate is set on a slant in front of the packer so the melons will stay where they are placed. The "bulge" on the crate which is being nailed up at the right insures a solid pack that will carry well and attract the buying trade.

and packing are two distinct operations, the proper performance of each requiring special ability and training.

The aim of the shipper should be to place his cantaloupes on the various markets in such condition that when they have passed through the regular channels of distribution in a reasonable time, they will be in prime shape for consumption whether it be in a near-by or distant market. It is a well-known fact that the flavor of many commercial fruits is sacrificed because they are picked when too green. This is especially true of cantaloupes, and every effort should be made to avoid placing any prematurely-harvested fruit on the market.

It often happens that markets west of the Mississippi receive quantities of western melons entirely too green for use, while on eastern markets the stock arrives overripe, possibly showing signs of decay. The demand in both sections is, of course, for sound stock ripe enough for use, but neither overripe nor green. Such conditions make it essential that cantaloupes be graded and loaded for near-by or distant markets according to their degree of ripeness, if best results are to be obtained.

CENTRAL PACKING HOUSES.

Community or central packing houses may serve as a factor in solving some of the problems of the cantaloupe grower in well-developed producing areas. In sections where the melons are marketed through a growers' cooperative marketing organization



FIG. 16.—View under cantaloupe receiving and loading shed at Ordway, Colo. The melons loaded here are practically all "pink meats." The inspectors are feeling of the cantaloupes as they receive them from growers' wagon in order to judge the ripeness and netting. However, the paper wrapper prevents a thorough inspection.

it should not be difficult to put such a system into operation. Of course, it would not be practical to pack all the cantaloupes grown in a large section in one central packing house, but growers in various localities about a shipping point could arrange easily to deliver their melons for grading and packing to large community packing sheds centrally located in their immediate district. Under such a plan it would be desirable to have competent field men make frequent inspections of the growers' fields in order to advise them regarding the proper time to pick, and to reject diseased or undesirable patches. In addition, it would be necessary to employ experienced graders and packers and an efficient foreman to see that every crate leaving the packing house is strictly up to standard in quality and appearance.

Instead of allowing the packer to perform all the functions of grading, sizing, wrapping, and packing at the packing house a grader should discard the culls, including all cracked, overripe, green, poorly netted, or otherwise defective fruit. If located a long distance from market, the good stock should be sorted for ripeness into at least two grades—to carry medium and long distances. In some places far distant from market it would be advisable to make a third grade of "ripes" to be sold in cities within a day's haul. As far as practicable the grader also should sort the melons according to size so that the work of the packers would be facilitated. With this done the packer would have only to watch for the possible mistakes of the grader, to wrap, if this is practiced, and to secure a smooth, uniform, and tight pack. It is impossible for a worker to secure such a pack unless his melons are properly graded to size (fig. 9).



FIG. 17.—Crated cantaloupes exposed to the sun on a hot day to be loaded later into refrigerator cars. The heat absorbed in this way hastens the ripening process and also increases the time and amount of ice necessary to cool the fruit when loaded.

If cantaloupe growers in general knew the great degree to which a tight, bulging pack aids in the disposal of their fruit or how a loose, uneven pack militates against ready sale and good prices, they would never allow a crate to leave their packing house in poor condition.

One of the oldest and most progressive growers in the country divides his packing-house operations into three divisions—sorting by experienced workers to eliminate all imperfect fruit, sizing by power machinery, and packing. His two machines are capable of handling eight carloads a day. The melons are brushed thoroughly and graded mechanically into three sizes—4, $4\frac{1}{2}$, and 5 inches—to fit his crates.

HAULING TO CAR AND LOADING.

Cantaloupes, like all other fruits which are to be refrigerated, should be loaded into iced cars as soon as possible after picking. The grower ought so to time the operations in his field and packing house that the crated product can be hauled to the loading platform without delay. In figure 17 cantaloupes are shown waiting in the sun the greater part of a hot midsummer day to be loaded into refrigerator cars. It is not difficult to imagine the damage that usually follows such treatment. The process of ripening not only proceeds very rapidly but the cantaloupes absorb so much heat that it takes a long time and consumes much ice to reduce the fruit to a proper temperature.

In hauling cantaloupes from the packing shed to the car growers should use wagons equipped with good springs and provided with



FIG. 18.—Interior of refrigerator car being loaded with "pink meats" in flats at Ordway, Colo. Note separation of rows to allow free circulation of cold air, and car cleats between every two layers of crates.

tarpaulin covers to protect the melons from the sun, rain, or dust. Sometimes drivers or others are seen seated or standing on the crated cantaloupes loaded flat in the wagon. If the crates must be used for a wagon seat, they should be placed on end.

In loading refrigerator cars (fig. 18) care should be exercised to see that sufficient space is left for the proper diffusion of the cold air. The tiers of crates should be spaced across the car so as to allow the freest possible circulation of air from end to end. All cantaloupes should be loaded flat, never on end or, in the case of flat crates, never on edge. In loading standard crates for a long haul it is customary to cleat each row, but in the case of flat crates only every second row is cleated (fig. 18).

In the eastern producing areas with near-by markets, no vacant space is left in the doorway when the car is loaded, but the crates are placed end to end until they fill the entire length of the car. In this way the average car is loaded with about 336 standard crates. In case the crates do not fit tightly in the car it is important that car cleats or pieces of "two by four" be placed in what little vacant space is left, so as to prevent the shifting of the load.

Most of the far western shipping sections, however, load their cars so that an unfilled space is left in the middle of the car, approximately from 2 to 4 feet in width. The load in each end is held in place by bracing heavily with "two by fours." As the bracing and the time required to install it form an appreciable expense item, this style of loading is not popular where the contents of the car will carry well without it.

WRAPPING CANTALOUPE.

The advisability of wrapping cantaloupes, as usually practiced in California, Arizona, Nevada, and with the pink meats in Colorado, is a much discussed question. Wrappers certainly add to the attractiveness of the package until the colored paper fades or is torn to allow inspection of the fruit by buyers, and they may have some effect in preventing decay from spreading from one melon to another. However, the sentiment of the buying trade in several markets seems to be turning against the practice. Dealers charge that wrappers tend to promote decay by preventing the evaporation of the moisture which collects on the fruit when it is taken from a refrigerated car. Wrappers also hinder proper inspection of the melons by buyers, and are a source of trouble if it is necessary for the dealer to sort and repack a crate.

Viewed at the producing point also, objections are seen to wrapping cantaloupes, since it allows those who wish, to cover up and pack defective melons which otherwise would be thrown out, and, further, renders satisfactory inspection practically impossible.

It is not desired, however, to sanction or condemn this practice until a more thorough investigation has been made. In the meantime, each shipping section using the paper wrapper will do well to observe the results carefully, both at the point of production and in the markets. The objections met can be balanced against the practical advantages apparent, thus making it possible for each producing area to decide the matter for itself in an intelligent way.

BRAND MARKS AND LABELS.

Cooperative marketing associations, firms acting as distributors, and many individual shippers of cantaloupes use a lithographed label or stenciled brand mark on their cantaloupe packages. They find it

the best basis upon which to carry on an advertising campaign and build up a reputation and demand for their goods. Labels with attractive designs also add greatly to the neatness of the packages. If a grower makes a yearly business of producing cantaloupes, there is no doubt that he will profit by the use of a brand name under which all his stock that grades up to a certain standard is sold. A brand name is particularly necessary if a grower is producing a superior cantaloupe and endeavoring to attract trade through the medium of high quality. Dealers and consumers alike must know the brand name of the fruit if they are to repeat their orders.

However, a distinctive brand is of little value unless it is associated with a certain standard of quality brought about and maintained by the constant enforcement of uniform rules governing the grading and packing of the cantaloupes. The standard of a brand once established should never be lowered or it will come to mean little among buyers on the market and the grower will suffer as a consequence.

In connection with this discussion of brand names and labels for cantaloupe packages, it may be expedient to quote "Food Inspection Decision No. 115, on the use of geographical names," approved February 23, 1910, for the benefit of growers, shippers, and distributors of cantaloupes who are not acquainted with it.

Regulation 19 of Circular 21, under captions (b) and (c) contains the following:

"(b) The use of a geographical name shall not be permitted in connection with a food or drug product not manufactured or produced in that place, when such name indicates that the article was manufactured or produced in that place.

"(c) The use of a geographical name in connection with a food or drug product will not be deemed a misbranding when by reason of long usage it has come to represent a generic term and is used to indicate a style, type, or brand; but in all such cases the State or Territory where any such article is manufactured or produced shall be stated upon the principal label."

There are many cases which have been considered by the Board of Food and Drug Inspection in which it has been necessary to decide whether or not, in its opinion, certain geographical names have been sufficiently generic to indicate a style, type, or brand, and in consequence might be used without offending any of the provisions of the food and drugs act. Among the geographical names which have been under consideration are "Rocky Ford" as applied to cantaloupes and "Indian River" as applied to oranges.

The Rocky Ford melon is not a new variety of melon, but is one of the older varieties of melons which in the environment of Rocky Ford, Colo., has attained particular excellence.

The same remark applies to the Indian River oranges of Florida. They are not a new variety, but various varieties which in the environment of the Indian River have attained unusual excellence.

The board holds that the terms "Rocky Ford" and "Indian River" have not become sufficiently generic to indicate styles, types, or brands of melons and oranges, respectively, but that these geographical names are only properly applied to the product of the restricted area for the melons which are grown in or near Rocky Ford and for the product grown in or near the Indian River.

Inasmuch as the term "Rocky Ford" has thus become associated with a melon of peculiar excellence of a certain geographical locality, the board holds that it is unlawful to sell in interstate commerce melons not grown in the Rocky Ford district as "Rocky Ford Seed" melons. The terms are nearly alike, the intent is to deceive, and the law provides that a label should not be false or deceptive in any particular.

SUMMARY.

The greatly increased production of cantaloupes with the resulting keener competition on the market makes it more necessary than ever that every commercial grower shall produce fruit of fine quality through intelligent choice of ground, careful selection of seed, and proper cultivation.

Particular attention should be given to the proper picking of cantaloupes, so that they will carry to the markets in the best possible condition.

As in the case of all perishable fruits, cantaloupes should be handled rapidly and with care throughout all the operations of harvesting, grading, packing, and loading on the cars, so as to avoid general deterioration or bruises with consequent decay.

Too many types and sizes of shipping packages are employed in the cantaloupe-producing areas of the country. For better marketing results, the various sections should unite in using new, well-made containers of uniform size and style. The full-sized standard crate and the standard flat crate meet most demands and should be used as far as practicable.

When possible, grading and packing should be treated as distinct operations and performed by different and specially trained workers. The grader should not only throw out all undesirable fruit, but should grade the cantaloupes according to ripeness for long and short hauls. The packer should be free to give his attention to securing a pack of standard count which is both tight and attractive.

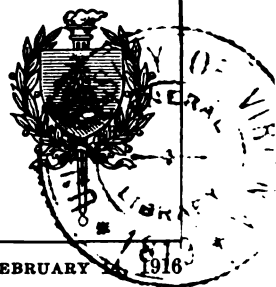
To obtain the much-needed improvement in the grading and packing of cantaloupes, it is suggested that in the larger producing centers community packing houses be established where each grower may bring his cantaloupes to be graded and packed by trained workers according to strict grading rules made by a governing body.

Distinctive brands and labels for selling associations or large individual shippers are very desirable as a basis for advertising and building up a reputation for their product. Well-designed labels or stencil marks add much to the attractiveness of packages. Brands are practically valueless, however, unless backed by strict grading rules which govern the quality of the fruit packed under them.

UNITED STATES DEPARTMENT OF AGRICULTURE



FARMERS' BULLETIN



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Contribution from the Bureau of Entomology, L. O. Howard, Chief.

THE LEOPARD MOTH:¹ A DANGEROUS IMPORTED INSECT ENEMY OF SHADE TREES.

By L. O. HOWARD and F. H. CHITTENDEN.

INTRODUCTION.

Along the Atlantic seaboard from eastern Massachusetts to southern New Jersey, and in the Hudson River Valley, shade and ornamental trees and shrubs of many kinds, with the exception of evergreens, are severely injured by the larva or caterpillar of the European leopard moth. Around such centers as Boston and New York, and in the State of New Jersey, this insect constitutes a most serious menace to the growth of shade trees. The larva of the leopard moth does not feed on the foliage, as do most of our shade-tree caterpillars, but bores into the branches and feeds upon the living wood. It usually begins operations in twigs and small branches and trunks; this work has the effect of girdling and so weakens the wood that the portion beyond the injury is often broken by heavy wind storms, while in the case of severe attack, especially to young trees, the growth of the tree is checked and death frequently follows. Attack is not confined solely to shade and ornamental plants, but orchards also are often injured.

DESCRIPTION.

The leopard moth derives its name from the spotted appearance of the adults as illustrated at *a* and *b* in figure 1. There is a great difference in size between the sexes, the female (*a*), which is a heavy-bodied moth and a very feeble flier, being much the larger. The male (*b*), on the other hand, has a more slender body, which insures ready flight, and is further distinguished from the female by the fact that its antennæ, or feelers, are broad and feathery. The wings are semi-

¹ *Zeuzera pyrina* Fab.; order Lepidoptera, family Cossidae. Synonyms: *Zeuzera aesculi* L. and *Z. decipiens* Kirby.

NOTE.—This bulletin is of interest to growers of shade and ornamental trees, especially in the New England and North Atlantic States.

transparent and white, thickly dotted with blackish spots which are more or less distinctly tinged, giving them a dark-blue or greenish cast. The thorax is white and has six large black spots and one small one, this last being in the center. The abdomen is white, with dark crossbands. The female has a wing spread of something over $1\frac{1}{2}$ inches, while that of the male is much less.

The eggs are oval and salmon colored.

The larva, which is the form that inflicts the injury, is a fleshy, grublike caterpillar of pale-yellow color, very frequently with a pinkish tinge, especially when reaching full growth. The head,

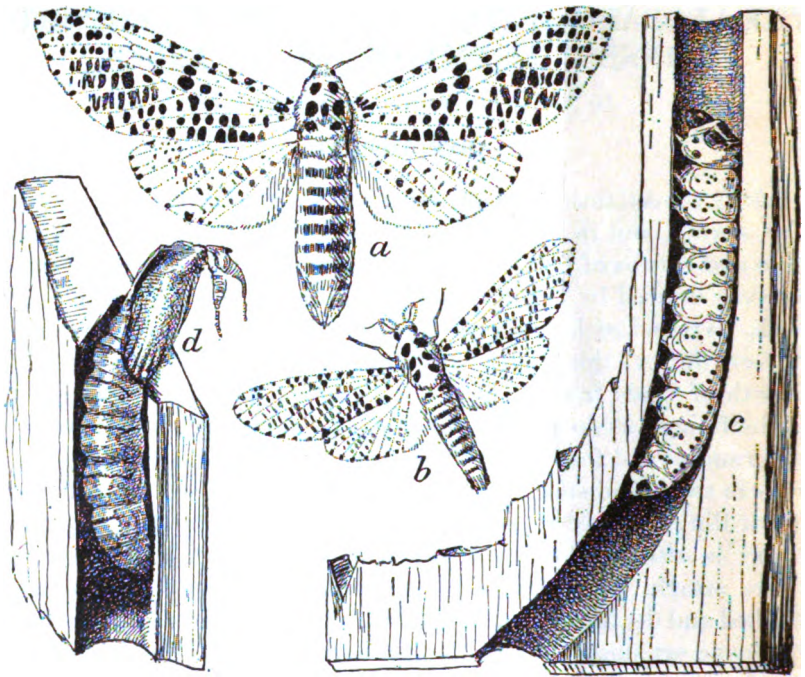


FIG. 1.—The leopard moth (*Zeuzera pyrina*): a, Adult female; b, adult male; c, larva; d, empty pupal case. Enlarged. (Authors' illustration.)

thorax, and plates on the hind end of the body above are brownish black, and the entire surface of the body is sparsely hairy and covered with large and prominent tubercles arranged as shown in figure 1, c, which illustrates the larva in natural position when at work in a tunnel which it has constructed in the solid living wood. When the larva has completed its growth it is fully 2 inches in length.

The pupa, or chrysalis, to which the full-grown larva changes, is very similar to that of other wood-boring caterpillars. On its head is a sharp protuberance which helps it in pushing its way partly out of the burrow preparatory to the emergence of the moth. The

appearance of the pupa is shown in figure 1 at *d*, which illustrates the empty pupal case projecting from the burrow, as the moth has left it.

ORIGINAL HOME; SPREAD AND PRESENT DISTRIBUTION.

The leopard moth, like so many other dangerous pests, is a European species which has been accidentally introduced into the United States in comparatively recent years. Its Old World distribution, as recorded, is central and southern Europe, southern Sweden, southwestern Africa, Algeria, northern Morocco, and the western portion of Asia Minor.

This species was introduced into the United States sometime prior to 1879; in this year a living moth was captured in a spider's web at Hoboken, N. J. In 1887 it was seen at Newark, N. J., but was not actually recorded as occurring in this country until the following year. In 1890 the moths were observed at electric lights at Orange, N. J. In 1894 its destructive ravages were recognized in Central Park, in New York City.

Fortunately the spread of this insect, particularly in the immediate vicinity of New York City, has been very slow, a fact which may be attributed to several causes: (1) The slow and feeble flight of the female, (2) the dominance of sparrows and squirrels in large cities, causing our native birds, such as woodpeckers, to be driven to the country, where they destroyed the moths, and (3) the bowl-shaped electric-light globes, open at the top and closed at the bottom, which were formerly in general use in our large cities. The males are strongly attracted to brilliant lights, and many were captured and perished in these globes in earlier years.

Specimens were collected at Bridgeport, Conn., in 1901. The species now occurs on Staten Island and has spread on Long Island well beyond the confines of greater New York. Southward it was reported a pest, in 1901, at Ocean Grove, N. J., and by 1905 was recorded at Kensico, N. Y., 25 miles north of New York City. By 1907 it was captured at New Haven, Conn. In 1908 it appeared in injurious numbers in the vicinity of Boston, Mass., where it seriously attacked the large elms on the Harvard University campus, and has since spread to more distant localities, specimens having been received from Lynn and from the island of Nantucket. It has been received from at least one locality in Rhode Island. Other towns and cities are indicated on the map (fig. 2), on which the southward limit, Woodbury, N. J., is shown.

On the occasion of a visit to New York City in recent years the junior writer was unable to find this insect or any evidence of its injury in the parks of Manhattan and Harlem. In side streets in the

vicinity of the parks, however, there were signs of extensive injury, and a number of trees had been removed, evidently because of death due to borer attack. Inquiry of the State entomologist and others failed to elicit any information in regard to new localities. The species has not been found in Pennsylvania so far as can be deter-



FIG. 2.—Map showing known distribution of the leopard moth in the United States in 1915. (Original.)

mined, nor has it spread to any extent from the localities which have been mentioned.

Information has been received that this species is less serious in its attacks to trees in the vicinity of New Haven, Conn., than it was six or eight years prior to the date of this publication. Taking

everything into consideration, it would seem that the species, while distributed along the coast, will, in time, be greatly reduced in this region, probably by parasites and other natural enemies, and will very gradually spread inland as it is now doing.

FOOD PLANTS.

In its Old World home the leopard moth is recorded as living on a considerable number of common trees, including elm, lime or linden, ash, beech, birch, walnut, oak, chestnut, poplar, alder, and, rarely, horse-chestnut. Among orchard trees it is reported to injure pear, apple, plum, and other fruit trees.

In the United States it attacks all of these trees and in addition practically all of the maples, ash, mountain ash, tulip tree, dogwood, aspen, and willows, such shrubs as privet and lilac, and honeysuckle. A list of 83 trees and shrubs which this larva has been actually observed to attack was compiled in 1894; 77 of these were observed in the public parks of New York City alone. A later list contains 125 species and varieties.

It will be seen by the list of food plants already presented that the number could be almost indefinitely extended, particularly in reservations like Central Park, New York City, and Prospect Park, Brooklyn, where special effort has been made to bring together a great variety of trees and shrubs. The insect will attack practically all forms of woody plants which are of suitable size for its purpose, with the exception of evergreens.

LIFE HISTORY AND HABITS.

In Europe the moths make their first appearance during July and August, but in this country they appear as early as May and continue issuing from the injured wood until late in September.

The female ready for egg laying, being particularly heavy, is unable to fly very far or very high. She deposits her eggs singly and in groups of three to four or more, and as many as 800 eggs laid by a single moth have been counted. The eggs are generally inserted in crevices in the rough bark of trees.

The larvæ hatch in about 10 days, penetrate the wood, frequently entering the nearest crotch, but also boring in at other points, and burrow tunnels into the heart or pith of twigs and the heartwood of the larger branches or trunks. When a larva has grown too large for the branch in which it is feeding it crawls out and enters a larger one. In a single tree 6 inches in diameter as many as six larvæ were observed, any one of which would have been able ultimately to destroy the tree if not removed; in fact, six to eight borers to the tree have been reported as an average in a badly infested location, and in one

instance 34 were found in a single tree. By the time the larvæ within have attained full growth, infested limbs of a certain size are likely to break off, especially during or after a severe storm, for the full-grown larva in many cases girdles the branch. The manner of girdling is shown at the top of the section of wood illustrated in figure 3. In 1893, after every storm in Central Park immense numbers of limbs were seen, some entirely broken off and others still hanging to the trees.

The larva when fully mature transforms to the pupa within its burrow, the change beginning to occur during the second May after the hatching of the eggs. The larva thus requires nearly two years to complete its growth. The pupa, by means of the sharp protuberance on its head, is enabled to force its way partly out of the burrow, after which the skin splits open and the moth emerges. The empty pupal skin remains for some time projecting from the orifice. (Fig. 1, d.)

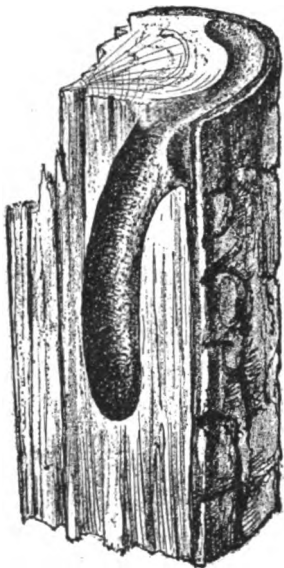


FIG. 3.—Section of wood showing burrow and girdling effect produced by larva of leopard moth. Reduced. (From Insect Life.)

The presence of this borer in a branch is manifested by an accumulation of chips, matted excrement, and frass, which indicates the entrance to the burrow. After a time these holes are closed from within by a silken web, doubtless to protect the contained insect from its natural enemies. Smaller twigs wilt and break off, and often the work of the insect is first recognized only when the severed twigs or branches have been brought down in numbers by high winds. Where the larger larvæ have worked just under the bark this splits open the next season, leaving an ugly scar as a reminder of its pernicious operations. (Fig. 4.)

NATURAL ENEMIES.

No specific natural enemies of the leopard moth other than birds appear to have been recorded in this country, although in Europe three or four wasplike parasites¹ have been reared.

In the explanation of the slow spread of the leopard moth from cities and large towns to the country, allusion has been made to the fact that native birds assist, to some extent at least, in holding

¹ An indeterminate chalcidid of the subfamily Encyrtinae—perhaps (*Copidosoma*) *Latomatrix truncatellum* Dalm.—and *Schreineria zeuzeræ* Ashm., *Microgaster* sp., and one proctotrypid.

this insect in check in the suburbs. There are the best of reasons for believing that birds like the woodpeckers, which naturally look over the bark and collect all kinds of borers, prey on this species; even sparrows, it is believed, sometimes destroy the eggs and young larvæ, as they are known to devour the moths. It is also believed that when the insect succeeds in getting away from the outskirts of cities its enemies increase in number, many insectivorous birds aiding in keeping it down.

During the day the moths are fed upon by birds and later by bats and night-flying birds. The habit of the larvæ of deserting one twig and migrating to a larger one undoubtedly leaves them exposed to the same natural enemies, as this migration has been observed to take place in the daytime as well as after nightfall. It follows that the protection of native birds, especially the woodpeckers and those of related habits, will greatly assist in restraining the undue increase and spread of this borer.

Squirrels, especially the gray squirrel, which is becoming common in our large cities, have also been observed feasting on the larvæ, but neither sparrow nor squirrel should be encouraged because of this habit, since both are responsible for driving away many of our native birds.



FIG. 4.—Work of the leopard moth in branch of maple. About natural size. (Original.)

METHODS OF CONTROL.

The protected and concealed manner of life of this borer, as shown by the life history, which will apply in the main to borers in general, renders it very difficult of treatment by means of insecticides or other direct measures. The most efficacious remedial measure consists in cutting off and destroying affected branches and in the injection of bisulphid of carbon into the holes or burrows where the larvæ are at work.

PRUNING AND CUTTING BACK.

Twigs or branches which, by their wilting or by the presence of burrows showing accumulations of frass or sawdust-like castings at their entrances, indicate the presence of this borer should be carefully searched out, the smaller ones pruned away and the larger ones cut back, and the amputated portions promptly burned. The stubs should be coated, preferably with grafting wax, to prevent the entrance of other insects or the spores of decay-producing fungi, although coal-tar preparations containing mineral substances are in somewhat general use for this purpose. After windstorms the affected branches which have fallen to the ground and those which remain attached to the tree should be collected and burned. Whenever trees show that they are past recovery it is best to take them out and promptly destroy them. The word "promptly" is used advisedly, since this insect, as previously stated, frequently migrates from one twig or branch to another.

INJECTING BISULPHID OF CARBON.

In the case of young and rare trees and others which show only a few larval burrows in the bark, bisulphid of carbon is the best remedy and one which has been in general use against the present species in the public parks of New York City. It is injected into the openings of the burrows, and the openings are immediately afterwards closed with various substances. For this injection a mechanic's long-spouted oil can of small size may be used on large trees, but against a related species the writers have made very good use of a small glass syringe, such as may be purchased at drug stores for about 10 cents. These glass syringes are most serviceable, because the exact amount of bisulphid may be seen when drawn into the syringe and because there is no threading to be injured by the reagent. Metal syringes may also be used, but it is more difficult to measure the exact amount, and the bisulphid acts on the leather packing. Rubber syringes are not serviceable because of rapid corrosion. About a teaspoonful of the liquid bisulphid is sufficient for each burrow.

For stopping the holes after injecting the liquid, putty and moist clay, advised by some, have been found practically useless. Grafting wax, on the other hand, gives perfect satisfaction. Coal tar is less advisable but may be substituted for the latter, or the holes may be closed by inserting a wooden plug and breaking or sawing it off even with the trunk. In any case the stopper should be tight, to exclude water from rains, which might tend to produce decomposition of the surrounding wood or invite the entrance of other insects, like carpenter and other ants and secondary borers, of which there are many species, and injurious fungi.

Carbon bisulphid should be handled with the usual precautions against fire, which means that the operator should not smoke while at work. Although the fumes should not be inhaled, as they are poisonous, the liquid will not injure ordinary trees when applied as described and does no harm to the hands.

KILLING WITH WIRES.

It is possible to reach and destroy many larvæ by forcing a copper or other pliable wire into the channels. This is a well-known borer remedy. It is impossible, however, by this means to kill the insects in all cases, owing to the length or crookedness of the burrows. Bisulphid of carbon should then be used.

ATTRACTING TO LIGHTS.

To what extent electric or other bright lights are serviceable as an agency in the destruction of the moths of this borer has not been definitely determined, but they possess a certain value. A method frequently advised consists in placing shallow pans around electric-light poles in and about parks to attract the moths. The pans are partially filled with water, and a small quantity of kerosene is poured into them. The moths flying against the globes drop into the pans and are promptly killed when they come in contact with the oil. In this way many males can be destroyed.

TREE INSPECTION.¹

In large parks the destruction wrought by this borer annually is an important item, and it will be found profitable to establish a system of inspection consisting in the employment of park keepers

¹ During the last years of the nineteenth century a long row of beautiful red oaks bordering the street between the grounds of the Department of Agriculture and those of the Smithsonian Institution were badly infested by the related carpenter worm (*Prionoxystus robiniae* Forst.). Nearly every tree was infested, and frequently two or three burrows showed near the tops of the trunks. Bisulphid of carbon was applied, as described above, and the holes closed with grafting wax. A year later no insects could be found at work, but wherever this remedy had been applied a small scar remained. Two years later these had entirely disappeared, and the trees looked as if they had never been infested.

and boys and others who may be engaged at lower wages to keep a constant lookout for evidences of borer attack on valuable trees. In 1893 a New York entomologist spent two months in fighting this insect alone in the city parks of New York, collecting wagonloads of limbs and branches and destroying the contained larvæ and pupæ.

MAINTAINING TREES IN THRIFTY CONDITION.

If valuable trees are to be protected, the insect should not be allowed to breed in useless growth. The borers in such trees should be destroyed or the trees promptly felled and burned. Care should be exercised in transplanting trees, and fertilizers should be used in order that the trees may be always thrifty, the better to withstand attack. This also means protection from the attack of aphides, scales and defoliators such as the white-marked tussock moth and the fall webworm, and keeping them free from disease.

PROMPT AND THOROUGH TREATMENT ESSENTIAL.

Finally, in the control of this species promptness and thoroughness can not be too strongly emphasized. The bisulphid of carbon remedy should always be used where applicable, and the inspection system advised should be instituted in all public parks and on city streets infested by this pest. Individual owners of valuable trees should become acquainted with the pernicious nature of this borer, and united action should be secured with neighbors whose trees suffer from the ravages of the pest.

PUBLICATIONS OF U. S. DEPARTMENT OF AGRICULTURE RELATING TO INSECTS AFFECTING SHADE AND ORNAMENTAL TREES AND HARDY SHRUBS.

AVAILABLE FOR FREE DISTRIBUTION.

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The Gipsy Moth and the Brown-tail Moth, with Suggestions for Their Control. (Farmers' Bulletin 564.)
San Jose Scale and Its Control. (Farmers' Bulletin 650.)
The Bagworm, an Injurious Shade-tree Insect. (Farmers' Bulletin 701.)
The Catalpa Sphinx. (Farmers' Bulletin 705.)
Rose-chaffer. (Entomology Circular 11.)
The Locust Borer. (Entomology Circular 83.)
Euonymus Scale. (Entomology Circular 114.)
Oyster-shell Scale and Scurfy Scale. (Entomology Circular 121.)
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The Hulsache Girdler. (Department Bulletin 184.)
Report on the Gipsy Moth Work in New England. (Department Bulletin 204.)
Dispersion of Gipsy Moth Larvæ by the Wind. (Department Bulletin 273.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS.

Three Insect Enemies of Shade Trees (Elm Leaf-beetle, White-marked Tussock Moth, and Fall Webworm). (Farmers' Bulletin 99.) Price, 5 cents.
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Report on Field Work against the Gipsy Moth and the Brown-tail Moth. (Entomology Bulletin 87.) Price, 35 cents.
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UNITED STATES DEPARTMENT OF AGRICULTURE



FARMERS' BULLETIN



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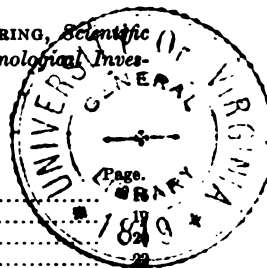
Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.

MUSCADINE GRAPES.

By GEORGE C. HUSMANN, *Pomologist in Charge*, and CHARLES DEARING, *Scientific Assistant, Viticultural Investigations, Office of Horticultural and Pomological Investigations.*

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INTRODUCTION.

The Muscadine grapes are native to and thrive in soil and under conditions suited to them throughout the entire southeastern Coastal Plain, from the James River to Florida, reaching well up into the Blue Ridge Mountains, and from Florida along the Gulf coast to Texas, and also northward along the Mississippi River to southeastern Missouri and the Tennessee River. (Fig. 1.) There are at least 250,000,000 acres of land in this territory which are well adapted to the culture of these grapes, a large percentage of it being at present untilled.

While the Muscadines have been more extensively grown than other grapes in much of this territory for some time, it is only during the last decade that their production has assumed real commercial importance.

BOTANICAL RELATION AND CLASSIFICATION.

The Muscadine grapes, which include two botanical species (*Rotundifolia* and *Munsoniana*), make up one of the groups of the genus *Vitis*.

The Muscadines are sometimes called "berry" grapes, because of a tendency of the individual berries in most varieties to shell off from the cluster as soon as ripe, instead of adhering as do the Euvitis (often called "bunch") grapes.

The Muscadines have hard wood, varying in color from ashy gray to grayish brown, or sometimes yellowish brown. While the bark adheres closely on the young branches and is never shreddy, it sheds annually on the older wood, especially on the trunks of vigorous-growing vines. The trunks have a tendency to split into several parts as the vines grow old (fig. 2), although very old vines often

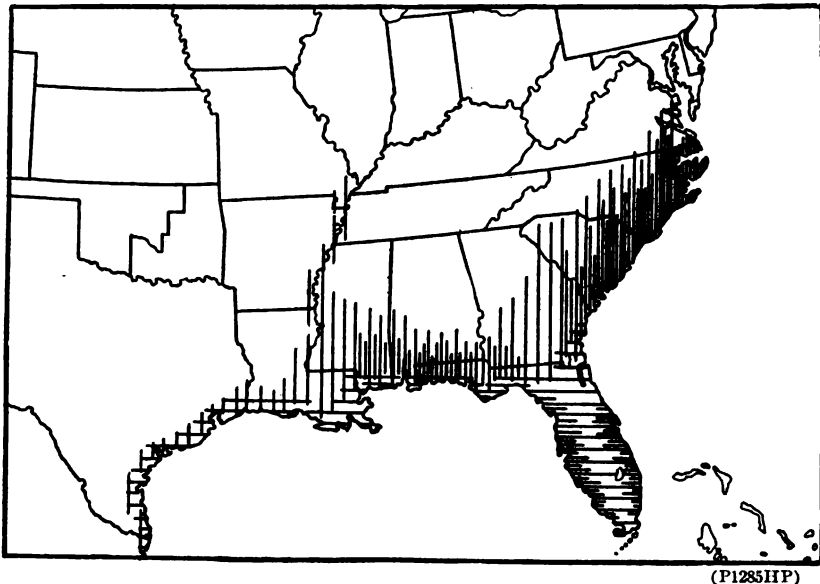


FIG. 1.—Sketch map of the southeastern portion of the United States, showing the natural distribution of Muscadine grapes. The vertical lines show the region where the *Rotundifolia* varieties grow and the horizontal lines the growing region of the *Munsoniana* varieties.

have solid, treelike trunks. Several trunks may develop if a vine is not trained when young. In the young canes the pith is continuous through the nodes. The young wood is covered with numerous small, prominent, warty lenticels. The growing shoots are yellowish or reddish at the tip when young, are short jointed, angled, or sometimes flattened, and have intermittent relatively long, tough, strong, unforked single tendrils of the same color as the twig to which they belong. The tendrils, when permitted to do so, may girdle even large branches. The leaves (figs. 3 and 4) are below medium size; smooth and shiny above and underneath; more or less round to broadly cordate, with a wide, rather shallow basal sinus; generally not lobed, though sometimes slightly three-lobed; and a prominently toothed margin.

The clusters are more or less roundish, ranging from loose to compact, and are relatively small, varying from 1 to 40, but generally of 4 to 10 berries. The berries are round and vary from very small to very large. They are green, pearly, bronze, red, or black in color, and are generally more or less speckled with reddish or russet dots. The skin is relatively thick; the pulp varies from meaty to melting and juicy; the seeds (fig. 5) are 2 to 4 in number (occasionally 5 or 6), and vary with the variety from small to very large. They are flattened, shallow, broad, notched, with very short pointed beak, and narrow raphe and chalaza, surrounded by radiating wrinkles. The leafing, flowering, and fruiting periods are late. In almost all fruiting varieties the pollen is practically sterile or entirely so. (Figs. 6 and 7.)

Of the two *Muscadina* species, *Vitis rotundifolia* is the more important, as all the prominent varieties belong to it and the species is native in practically the entire territory of the group.

Vitis munsoniana, on the other hand, is more like a subtropical variation of *Vitis rotundifolia* and is native only in Florida, the borders of the Gulf of Mexico, and possibly near the southeastern Georgia coast. *Vitis rotundifolia* (fig. 6) bears small clusters of large berries with large seed, while *Vitis munsoniana* (fig. 7) bears relatively large clusters of small berries (8 to 30) with small seed. *Munsoniana* vines are slender, more trailing, and do not climb as high as *Vitis rotundifolia*. Their leaves are generally smaller, with narrower basal sinuses and less numerous but more prominent marginal teeth. *Munsoniana* also has the ever-bearing habit, and in August buds, blooms, and fruit in all stages of development may be found on the vines at the same time.



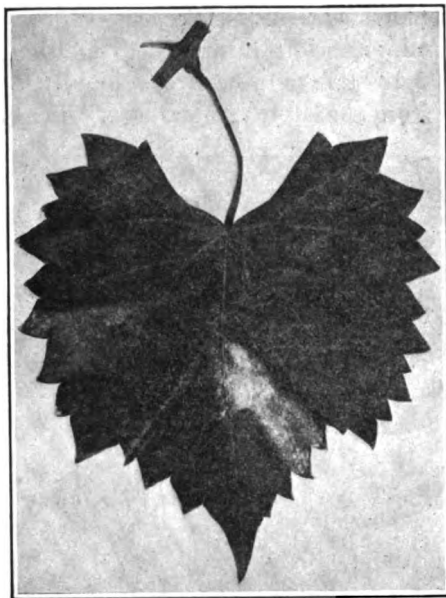
FIG. 2.—Trunk of an old *Rotundifolia* vine. (P2313HP)

PROPAGATION.

Muscadine grapes may be propagated from seed or by layers, cuttings, or grafts.¹

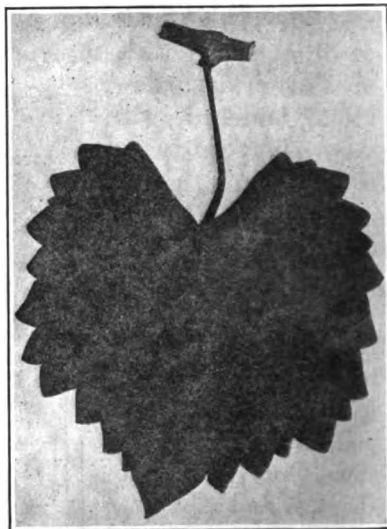
SEEDS.

Muscadine grapes should be



(P7819HP)

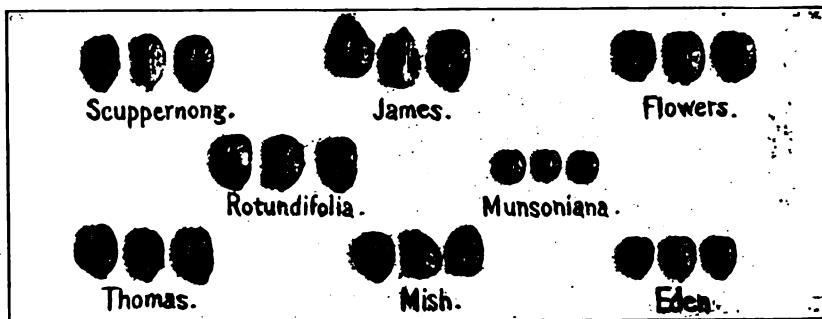
FIG. 3.—A Scuppernong leaf. (Two-thirds natural size.)



(P7823HP)

FIG. 4.—An Eden leaf. (Two-thirds natural size.)

grown from seed only when it is desired to produce new varieties. This is work for those interested in plant breeding.



(P7054HP)

FIG. 5.—Typical Rotundifolia and Munsoniana seeds.

CUTTINGS.

The United States Department of Agriculture has for several years been experimenting in propagating Muscadine grapes from cuttings

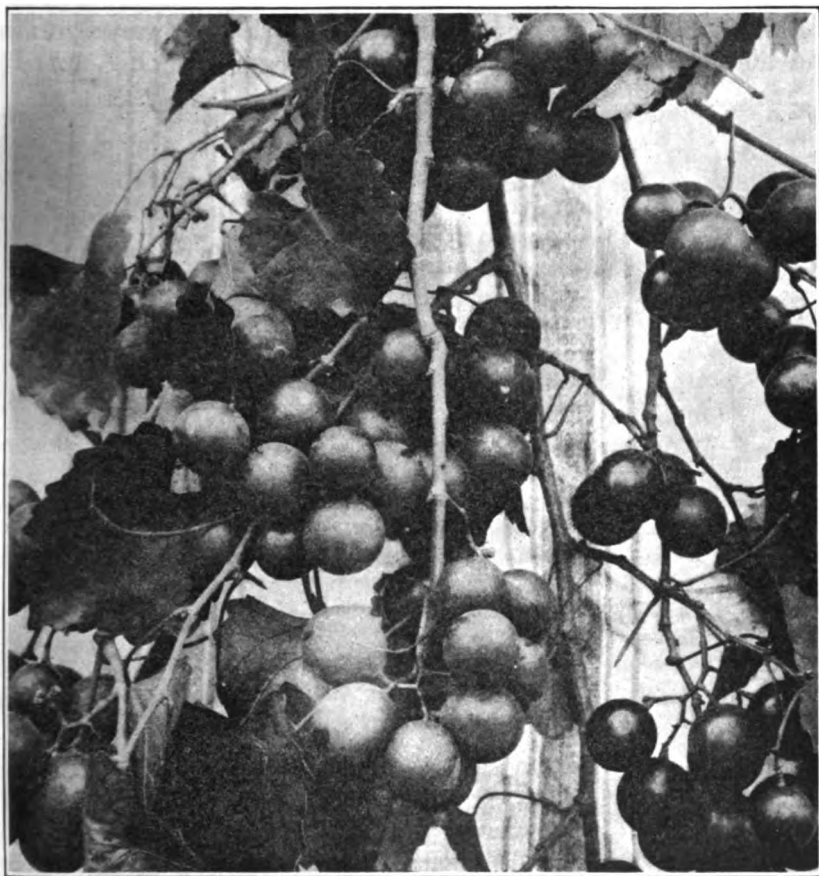
¹ For a description of methods of propagation, see the following publications:

Husmann, G. C. Grape propagation, pruning, and training. U. S. Dept. Agr., Farmers' Bul. 471, 29 p., 30 fig. 1911.

— and Dearing, Charles. The Muscadine grapes. U. S. Dept. Agr., Bur. Plant Indus. Bul. 273, 64 fig., 26 g., 11 pl. (1 col.). 1913.

(fig. 8), but so far no altogether satisfactory method has been found. The best results have been obtained by using long cuttings (15 inches) of short-jointed, medium-sized, well-ripened wood, cut in the early winter and stored in a callusing mound until about April 1, and then planted slanting in well-prepared ground, leaving only 1 or 2 inches projecting above the ground.

Considerable difference has been found to exist in the relative rooting qualities of the different varieties. Some of the staminate



(P6506HP)

FIG. 6.—Fruit and branches of *Vitis rotundifolia*. (About one-half natural size.)

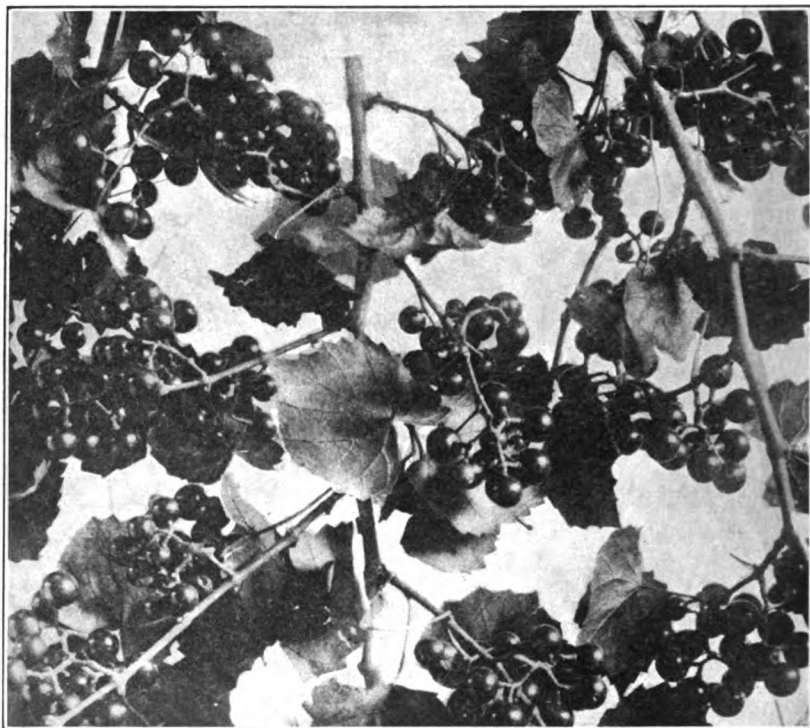
Muscadines root with relative ease. Of the commercial varieties, the Thomas and Flowers give the best results, the James being intermediate, and the Eden and Scuppernong rooting with the greatest difficulty. The best results with the Scuppernong were 4 per cent, while with the Thomas as high as 48 per cent of the cuttings have rooted. Vines grown from cuttings are, however, much better

than those from layers, and it is probable that when more information has been obtained on the subject it will be found desirable to propagate at least some of the varieties from cuttings.

One means of furthering the rooting of cuttings is to graft a small piece of root on the end of the cuttings and then treat such grafts as if they were cuttings. In this manner in a normal season 86 per cent of the Thomas and 20 per cent of the Scuppernong cuttings were rooted.

LAYERING.

Layering is the most common method practiced by grape growers and nurserymen in propagating Muscadine grapes. (Fig. 9.) By



(P18344HP)

FIG. 7.—Fruit and branches of *Vitis munsoniana*. (About one-half natural size.)

this method the greatest number of plants are produced at the least expense. Such plants are, however, often poorly shaped and difficult to handle. Canes may be layered at any season of the year, but most frequently in midsummer, when canes of the same season's growth are used. These are bent down to the ground and covered with earth, the growing tips being allowed to project above the soil. Roots will form by autumn and the layers can then be cut from the parent vines and divided, the laterals which were left usually

forming the tops of the new plants. After being divided, the plants should be thoroughly heeled in, like plants from seeds or cuttings. In general practice the layers are not disturbed until wanted for use in the spring.

Where vines are on overhead arbors, layers can be made by placing boxes of soil on the arbors and layering the canes into these boxes.

Nurserymen grow Muscadine vines especially for layering purposes, causing them to grow along the surface of the ground. Each season, in July (or in August in Florida), they cover the annual shoots with soil and cut away the rooted vines in winter, leaving the spurs which send forth new growth to be again layered the next season.

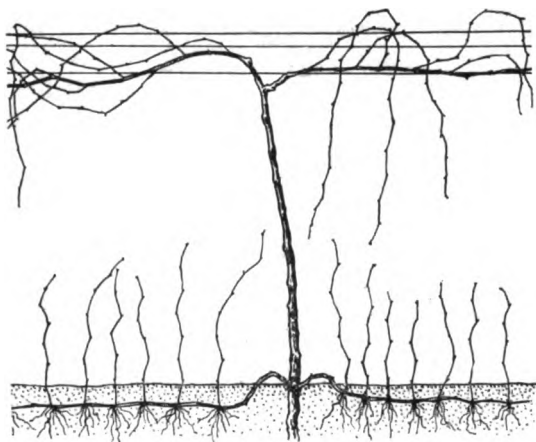
GRAFTING.

Grafting is seldom resorted to with Muscadine grapes, and those who have tried to graft them have



(P4671HP)

FIG. 8.—A bundle of grape cuttings.



(P6037HP)

FIG. 9.—Diagram of a grapevine with two canes layered, showing the method of propagation by layers.

not had flattering results. For that reason grafting is not described in this bulletin.¹ Some of the advantages of grafting in vineyard practice are: (1) New varieties may be rapidly brought into bearing by grafting on older, healthy, strong vines; (2) worthless vines may be changed into valuable ones by grafting them with such; (3) varieties which will not grow readily from cuttings can generally be easily grafted.

SOILS.

Muscadine grapes can be grown on almost any of the tillable soils of their natural habitat, but not with equal success; for example, they do not thrive in low, wet soil or on barren, clay hills. Generally

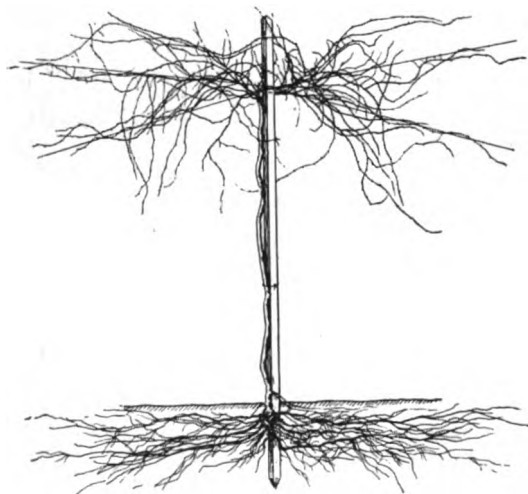
¹ For information on vine grafting, see Husmann, G. C., op. cit.

speaking, the best results with Muscadine grapes are obtained on sandy loam soils that are well drained and contain a fair amount of fertility and organic matter. Such soils abound throughout the southeastern Coastal Plain. Muscadine grapes also grow successfully in the better red-clay soils of the Piedmont section. It might also be said that these grapes thrive where cotton thrives and that any well-drained land in the tidewater section where hardwood as well as pine trees grow is good Muscadine grape land.

As the Muscadines have a shallow, near-the-surface, spreading root system (fig. 10), deep surface soils, though preferable, are not absolutely necessary. It is important, however, to have a good, well-drained subsoil. If hardpan clay is encountered near the surface it should be broken up with a subsoiling plow or, if neces-

sary, with sufficient charges of dynamite to break through it at the places where vines are to be set.

When once established, Muscadine vines will grow in fairly wet ground, though not so well as on better drained land; neither will the fruit be of as good quality; for which reasons wet soils are not recommended. Furthermore, it is practically impossible to get a stand of vines in such soil unless the rows



(P1201HP)

FIG. 10.—A Muscadine vine, showing its characteristic shallow, spreading root system.

where the vines are to be planted are temporarily drained by plowing a furrow away from them on either side, leaving the rows as narrow strips of land not more than 2 feet wide. After the plants have become established the furrows are closed by cross cultivation.

If the grapes are to be planted on new land it is best previously to grow a crop of tobacco, corn, cotton, or some other annual crop requiring cultivation and, if possible, a leguminous crop, such as cow-peas. This will get the ground in ideal condition for planting vines.

Muscadines grow vigorously when once established, but they have difficulty in starting, and a large percentage of the plants in new plantings will be lost if the soil is either too wet or too dry, or otherwise not in good condition for planting.

PLANTING.

How grapevines should be planted has been frequently discussed in department publications.¹ Muscadines are planted in much the same way as other grapevines. The best time to plant is in early spring.

The ground should, of course, be well prepared. Either 1 or 2 year old vines are suitable for planting, but strong 1-year-old plants are usually preferred.

Figure 11 represents plants of Muscadine grapes as they are received from the nursery. They should not be planted in a permanent location in this condition, but should be pruned before planting, as shown in figure 12. On 1-year-old plants the top should be shortened to the required length, and where the plants are more than 1 year old the top should be cut back to a single spur.

The hole in which the plant is to be set should be made wide enough to prevent crowding the roots and so deep that when the vine is planted only the top will be slightly above the ground. After the hole has been dug, a little good pulverized surface soil should be thrown into the bottom and the vine placed in position. Pulverized surface soil is then thrown in, worked between the roots of the plant, and the whole mass of soil firmed as the hole is filled.

It is very important that the roots of the vines be kept moist at all times during planting.

Efforts should be made to establish the roots as deep as possible in the soil, so as to make the vines more drought resistant and to prevent injury from future cultivation. This result is furthered by planting the vines as deep as the plowing and preparation given the soil will reasonably permit and after the vines are planted giving the soil deep and regular cultivation.

The distance apart that Muscadine grapes should be planted depends on the variety and the training system. The James and Flowers grapes can be grown closer together than vigorous varieties like the Thomas, Scuppernong, and Eden. More vines per acre can be grown successfully on the vertical than on the horizontal system. The relative advantages of these systems will be discussed later. Vines grown on the overhead-arbor trellis are usually planted 20 by 20 feet. It is the opinion, however, of those who have given the matter closest attention that it is much better to plant the vines about 10 by 10 or 12 by 12 feet apart and then thin out as they begin to crowd. In this manner much heavier yields per acre may be obtained from the first three or four harvests, and vineyard space is not wasted.

¹ Husmann, G. C. Grape propagation, pruning, and training. U. S. Dept. Agr., Farmers' Bul. 471, 29 p., 30 fig. 1911.

— and Dearing, Charles. The Muscadine grapes. U. S. Dept. Agr., Bur. Plant Indus. Bul. 273, 64 p., 26 fig., 11 pl. (1 col.). 1913.

The accompanying diagram (fig. 13), suggested by Mr. R. C. Cool, of North Carolina, illustrates a good method of planting for overhead training when the vines are set close with the intention of thinning them as they grow larger. By this plan the vines are set 10 by 10 feet apart. The location of the permanent vines (20 feet apart each way) is indicated by *P*. The vines represented by *X* and *O* should



FIG. 11.—Rotundifolia vines as received for planting.

(P16832HP)

be removed as soon as they begin to crowd. The *O* vines can remain two or three years longer than the *X* vines.

When vines are grown on a vertical trellis, a good distance for the Scuppernong and the stronger growing sorts would likely be rows 10 feet apart and vines 10 feet apart in the rows, thinning out later, as the vines begin to crowd, to 20 feet apart in the row, as indicated



FIG. 12.—Rotundifolia vines pruned ready for planting.

(P16832HP)

in the following diagram (fig. 14), in which *P* represents the permanent vines and *T* the temporary ones.

For varieties not as strong growing, the distances could be reduced to rows 8 feet apart with the vines 8 feet apart in the rows, thinning later, as the vines begin to crowd, to 16 feet apart in the rows. During the first growing season the vines can be supported by a stake. The next season the trellis will be required.

COMPANION CROPS.

During the first two seasons of a vineyard's life, companion crops should be grown in it, to build up the land and to furnish revenue to assist in meeting the expense of establishing the vines. After the vineyard has passed the third summer, the growing of companion crops should be viewed from the standpoint of their value in regulating the soil-moisture supply and fertility. In the first years of the vineyard, hoed crops, such as melons, tomatoes, peanuts, cotton, or tobacco, may be grown between the rows of vines. No corn and grain crops should be planted. Other leguminous crops, such as cowpeas and soy beans in the summer and vetch, bur clover, and crimson clover in the winter, may be grown for seed or for turning under the soil.

CULTIVATION.

It is now generally believed that Muscadine vineyards should have systematic cultivation, though the advisability of deep culture has

P	X	P	X	P	X	P	X	P	X
X	O	X	O	X	O	X	O	X	O
P	X	P	X	P	X	P	X	P	X
X	O	X	O	X	O	X	O	X	O
P	X	P	X	P	X	P	X	P	X

FIG. 13.—Diagram showing a method employed in alternating permanent and temporary plantings of grapevines when set close for overhead training: P, Permanent; O and X, temporary.

P	T	P	T	P	T	P
T	P	T	P	T	P	T
P	T	P	T	P	T	P
T	P	T	P	T	P	T
P	T	P	T	P	T	P

FIG. 14.—Diagram showing a method employed in alternating permanent and temporary plantings of grapevines grown on a vertical trellis: P, Permanent; T, temporary.

been questioned. If cultivation is started at the beginning and properly practiced at all times, the roots of the vines will strike deeper and it is believed there will be no serious root injury from cultivation. Especially is this true in well-drained soils.

In discussing proper vineyard culture it is necessary to refer in more detail to the growing of cover crops or companion crops. Culture and intercropping go hand in hand. It has been stated that the soil should be put into the best cultural condition before planting. It should be cultivated deep and well. Throughout the first summer a space of at least 2 feet on all sides of the vines should be kept under clean culture or the vines should be mulched. The rest of the ground may be devoted to companion or cover crops. If vines are planted as close as 10 by 10 feet and the grower can see his way clear to do so, it is best to intercrop the vineyard, with a view to aiding the vines to do their best. In this case cowpeas are usually grown during the summer, and the land is seeded down to bur clover, crimson clover, or hairy vetch in the early autumn.

Bur clover and hairy vetch reseed themselves if allowed to ripen their seed before the ground is cultivated. Crimson clover must be seeded each fall, but it is probably the best of the winter cover crops to grow in the vineyard, because it allows the ground to be broken earlier in the spring. Bur clover will yield abundant crops of seed that sell at a good price, but it prevents spring cultivation until nearly the first of June in North Carolina and does not afford as good early spring grazing.

The second season the ground should be broken and thoroughly harrowed as soon as the winter cover crop will permit. A strip of ground next the vines should be kept under clean culture throughout the summer, but the rest of the ground can again be planted to cow-



(P12869HP)

FIG. 15.—*Rotundifolia* vines with a leguminous cover crop growing between the rows.

peas (fig. 15). The summer crop should be followed by a leguminous cover crop, such as bur clover or vetch, during the winter.

During the first two years, if desired, it is perfectly feasible to grow one or two rows of cotton, potatoes, melons, peanuts, tomatoes, tobacco, or other similar crops that require clean culture, in place of cowpeas (fig. 16). If such crops are planted they should receive proper applications of fertilizer just as if they were planted alone. It will not harm the vines, when properly supported, to graze cows, sheep, or hogs on the winter cover crop in the vineyard in early spring before the vine growth starts.

After the second season the usual vineyard practice is to grow winter cover crops, such as bur clover, crimson clover, or vetch, each winter and to turn these under in the spring as soon as possible after grazing, cutting for hay, or harvesting for seed. Then the vineyard should have a thorough plowing, followed by cultivation through

the early part of the summer. Cowpeas are planted about midsummer, and if the winter cover crop does not reseed itself it should be seeded down in the early autumn under the cowpeas.

In cultivating and intercropping the bearing vineyard the condition of the vines should suggest the treatment to be followed. The use of cowpeas and other leguminous crops is emphasized, because under most conditions it is desirable to encourage growth. It is possible, however, to make rich soils too rich and thus cause an overproduction of wood growth at the expense of fruit. If such a condition should arise the grower should abandon the leguminous crops, grow a row of cotton between the vines, and in the autumn seed down to oats or rye. Generally, however, an excessive wood growth can



FIG. 16.—*Rotundifolia* vines grown with an intercrop.

(P7891HP)

be checked by allowing the vines more fruit-bearing surface or stopping the application of nitrogenous commercial fertilizers.

In plowing a bearing vineyard the plow should be run shallow near the vines, but the ground can be plowed deep farther away from the vine trunks if done regularly. The ground should be kept level, and if the soil is thrown toward the vines at one cultivation it should be thrown away from them at the next cultivation.

FERTILIZATION.

In order to get the best results with Muscadine grapes commercial fertilizers are usually required, in addition to good cultivation and intercropping. Young vines, especially during the first year after planting, require principally nitrogenous fertilizers, such as nitrate of soda, dried blood, and cottonseed meal. It is a good practice to mulch young vines with manure, where it is available. The object

of giving young vines heavy applications of fertilizer is to induce a robust growth which will make a vine capable of bearing a profitable crop the third year. Under ordinary conditions such results would be attained not earlier than the fourth year. Bearing vines require more phosphoric acid and potash than do young vines and should have only enough nitrogen to keep them in vigorous condition. If the cultural and intercropping directions given here are followed but little nitrogen will generally have to be added as commercial fertilizer. More fertilizer is, of course, required on poor sandy soil than on heavier loamy or clay-loam soils.

In order to give an idea of the quantity of fertilizer usually applied it may be said that in experiments at the Muscadine Grape Experiment Vineyard, Willard, N. C., a mixture analyzing 6 per cent phosphoric acid, 6 per cent potash, and 4 per cent nitrogen, applied at the rate of 600 pounds to the acre, is being used as a normal application. An experienced grower of North Carolina states that a safe rule is to apply and work well into the soil in the spring 400 pounds of acid phosphate and 75 to 100 pounds of muriate of potash per acre, adding light applications of nitrate of soda if the vines need it.

A well-informed grower in 1914 used on a vineyard in sand-hill soil, where the vine growth was not vigorous, a fertilizer containing a great quantity of materials, so as to have the plant food become available at different times during the season. Each ton of this mixture contained 106 pounds of nitrate of soda, 880 pounds of acid phosphate, 400 pounds of dried blood, 200 pounds of fish scrap, 208 pounds of sulphate of ammonia, and 206 pounds of muriate of potash. This fertilizer was assumed to contain 7 per cent of nitrogen, $8\frac{1}{2}$ per cent of phosphoric acid, and 5 per cent of potash. It was used at the rate of 2 to 4 pounds per vine, depending on the size of the vine.

POLLINATION.

The pollination of Muscadine grapes has been studied very closely by various investigators. It has been determined that the varieties ordinarily grown are practically self-sterile, notwithstanding the fact that the blossoms have both pistils and recurved pollen-bearing stamens. In order to produce berries they must therefore be cross-pollinated with the fertile pollen of staminate Muscadine vines. The male, or staminate, vines of course produce no fruit. It is estimated that probably 75 per cent of the wild Muscadine grapevines are staminate. It has been pretty accurately established that the pollen is carried from the male to the pistillate, or female or fruiting, vines almost entirely by insects. In the past there has been a sufficient number of staminate vines and of insects to insure the proper cross-pollination of vines. Now, however, as the Muscadine grapes are being planted in large vineyards and as the number of wild male vines is being reduced through the clearing up of the land, it becomes

essential to fruit production to plant male vines here and there in the vineyards. No experiments have been attempted to determine the proportion of male vines needed, but the opinion is common that one staminate vine should be planted for every 8 or 10 fruiting vines. Applying this rule to the diagrams illustrating the manner of planting which were presented as figures 13 and 14, every third vine in every third row, be it permanent or temporary, should be a male vine. In the diagram for planting overhead vineyards (fig. 13) the male vines should not be placed at the points represented by *O*. It is important to use only vigorous, heavy-blooming male vines that bloom simultaneously with the fruiting vines. In large vineyards of 100 or more acres it is believed that it will be profitable to locate bee-hives here and there about the center of the vineyards. When wild insect visitors come to a large vineyard they apparently have no incentive to go into the center of it so long as there is abundant bloom around the edges to supply their needs. The investigations of the Department of Agriculture show that while only 7 to 10 per cent of the Muscadine buds normally produce ripe berries, 20 to 30 per cent will produce berries if properly pollinated. This is equivalent to an increased yield per acre of approximately 200 to 300 per cent.

PRUNING AND TRAINING.

The system of training followed in the growing of Muscadine grapes for commercial purposes has been and still is mostly on overhead arbors. These vary from the crudest supports under the scattering vines seen about so many southern homes to the latest overhead wire supports used in commercial plantings. These wire supports are practically identical in construction with the *parrales* supports used in Spain in the growing of the Almerian or so-called Malaga grapes.

It is only during recent years that any attention has been given to the pruning of Muscadine vines. In fact, the statement has frequently been made to the writers by the more intelligent and extensively interested growers that Muscadine vines can not be pruned without killing them.

Careful experiments have not only proved that Muscadines can stand pruning but that pruning is really necessary for the best results and to insure permanent and lasting vineyards.

During the last decade much attention has been given to a study of pruning and training methods by those interested in Muscadine grapes. Considerable has been accomplished, but much remains yet to be done to arrive at positive conclusions as to what are the best methods of pruning and the best systems of training.

The fact that some persons advocate no pruning, others moderate pruning, and still others severe pruning shows that results are obtained with Muscadines by all these methods. The safest plan is to take an

intermediate course and follow moderate pruning until it is proved that some other course is better.

Two systems of training are employed with Muscadine grapes: (1) The horizontal or overhead system (fig. 17), by which the growth is spread as an overhead canopy about 7 feet above the ground and supported by posts, and (2) the upright or vertical system (figs. 18 and 19), in which the growth is spread over a trellis. The prospective grower will need to determine which system is best for him, as this bulletin is only intended to point out the strong and weak points of both.

In the overhead system a single trunk is caused to grow erect from the ground alongside a permanent post. When the vine has reached



(P8749HP)

FIG. 17.—*Rotundifolia* vines trained in accordance with the horizontal or overhead system.

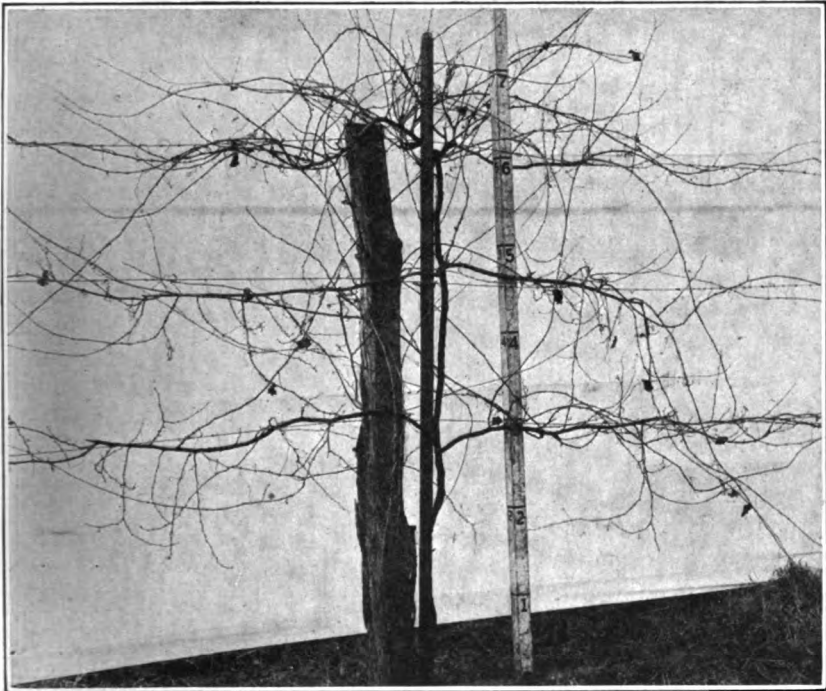
the top of the post it is pinched in or cut back, so as to make it throw out shoots to grow and spread out from the head of the vine as the spokes of a wheel radiate from the hub.

In the upright systems the fruiting arms are either radiated from a low vine head, like the ribs of a fan, or they are taken off as horizontal arms from a central vertical trunk (figs. 18 and 19).

Where the vineyard is not given close personal attention and pruning and other vineyard practices are neglected the best results will be obtained with the overhead trellis. Moreover, such a trellis permits cross-plowing and cultivation and is better adapted for grazing hogs, sheep, or cattle on cover crops grown in the vineyard. On the other hand, the careful vineyardist can expect the best and earliest results from vines on the upright or vertical supports. The upright

trellis facilitates pruning, harvesting, spraying, and intercropping throughout the life of the vineyard; it is also easier to repair and can be erected from \$10 to \$20 an acre cheaper than the overhead trellis. The use of both the upright system and the overhead trellis has netted the growers profitable returns. Each has its advantages and disadvantages. The prospective grower, knowing his own conditions, must determine which training system is best suited to his conditions.

During the first year after planting, a strong stake reaching 4 feet above the ground at each vine is sufficient support. A trellis should be erected the second season, though the upper wires of an upright



(P7864HP)

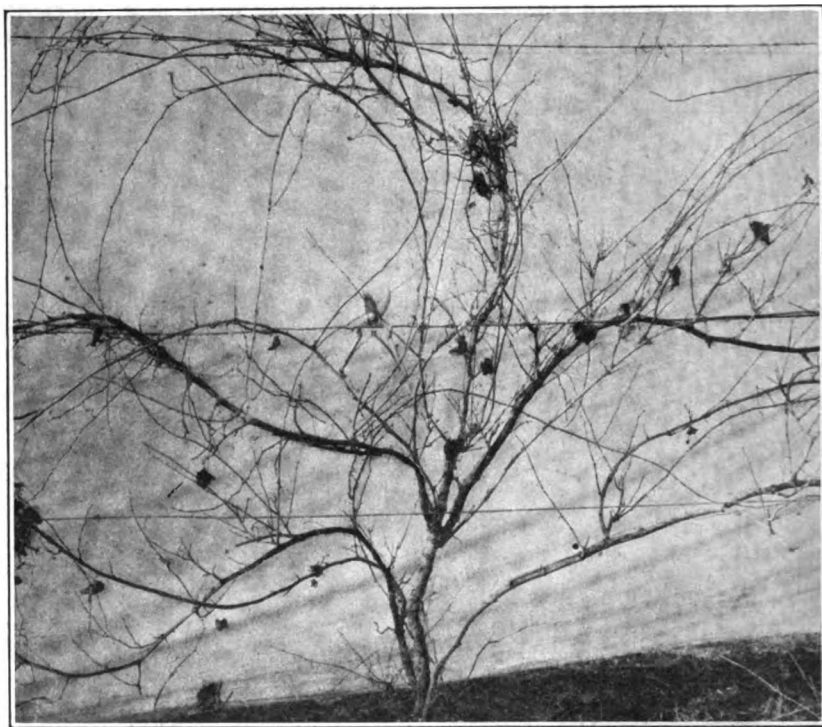
FIG. 18.—An unpruned *Rotundifolia* vine trained in accordance with the 6-arm renewal system.

trellis and the secondary wires of an overhead trellis may be added later, as the vines need them. In erecting an upright trellis the posts should be set midway between the vines, the distances apart varying with the distances between the plants. The end posts of the rows should be firmly braced. Three wires are generally used, placed 24, 42, and from 56 to 60 inches from the ground.

In erecting an overhead trellis, the usual method is to place a substantial, durable post reaching 7 feet above the ground at each of the permanent vines. Rows of extra-heavy, well-braced posts, running parallel with and also at the ends of the rows of vines, are

set at the boundaries of the vineyard. There are a number of different ways of arranging the wires. Usually No. 10 galvanized wires are securely fastened to the tops of the boundary posts on the four sides of a vineyard and then are run along and securely fastened on the tops of the inside posts down each row in both directions as governor wires. As needed, No. 14 wires 2 feet apart are run parallel with the governor wires until in this manner the entire area has been covered.

A cheaper but less durable overhead trellis is made by running No. 9 governor wires in only one direction and the secondary wires



(P12613HP)

FIG. 19.—An unpruned *Rotundifolia* vine trained in accordance with the radiating system.

only at right angles to the governor wires, the secondary wires being fastened to the governor wires wherever they cross.

Some growers construct arbors entirely of wood, using slats or poles instead of wires.

The pruning of Muscadine grapes during the first three years is mainly for the purpose of establishing the permanent parts and adjusting the other parts of the vine to the desired training system for future usefulness. After that the pruning is primarily a matter of renewing the bearing surface and keeping the vines healthy, vigorous, and productive.¹

¹ For the objects gained in pruning and the principles underlying pruning, see the following publication, which may be had on application to the United States Department of Agriculture: Husmann, G.C., *Grape propagation, pruning, and training*. U. S. Dept. Agr., Farmers' Bul. 471, 29 p., 30 fig. 1911.

During the first season the trunk of the vine should be established. From this the main fruiting branches are started the second season. These, under favorable circumstances, will bear a small crop of fruit the third season. After that the purpose of pruning should be to renew growth, to increase or decrease the bearing surface, and to maintain the shape of the vine.

Severe pruning usually removes most of the fruit-bearing wood and throws the vine into vigorous wood growth. No pruning, on the other hand, causes a growth which is too much distributed, weak, and incapable of bearing good crops. Therefore, the grape grower should study the vines sufficiently to enable him to judge each year the proper severity of pruning for the best results. This will depend on the variety, the age of the vines, the fertility of the soil, etc. Muscadine grapes bear their fruit in small clusters. It is therefore necessary to maintain a large fruiting surface in order to secure a proper tonnage of fruit. This is accomplished by developing a series of fruiting arms, spurring along these, and lengthening them as the vines become stronger. Such fruiting arms can be maintained for a number of years, but after a time it is desirable to renew them. This is done by cutting out the arm and starting a new one from a cane that has been previously grown for such purposes. It is preferable to renew systematically only one or, at most, two arms on a vine each year. This gradual renewal does not disturb the vigor of the vine, but keeps it productive, healthy, and strong. The pruning can be quickly and easily done if systematically practiced from the time the vines are started.

Figure 12 shows the manner of pruning Muscadines when planting, while figure 20 shows them at the end of the second, third, and fifth years, trained to the horizontal or overhead system; figure 21, at the end of the second, third, and fifth years, trained to the vertical radiating system; and figure 22, at the end of the second, third, and fifth years, trained to the vertical 6-arm renewal system; while figure 17 shows an older unpruned vine on the horizontal overhead system; figure 18, an older unpruned vine on the vertical 6-arm renewal system; and figure 19, an older unpruned vine on the vertical radiating system.

HARVESTING AND HANDLING.

When the fruit is intended for table use or shipping it should be hand picked. The varieties that do not shatter from the stem readily are the best for shipping. Such grapes should be carefully and attractively packed. The ordinary peach crate, strawberry crate, and 8-pound grape baskets are the containers generally used for such grapes. (Fig. 23.) The usual practice of harvesting Muscadine grapes for juice purposes is to jar them from the vines on to canvas or burlap sheets spread or carried under the vines. The

leaves, twigs, etc., accumulated with the fruit while jarring it from the vines are separated from it. This is usually done by running the mass through a fanning mill or by using a blowing apparatus. The jarred grapes are put into barrels and either hauled or shipped to the winery.

YIELDS AND RETURNS.

No accurate records of yield have been kept in the older commercial vineyards, so little authentic information is available along that line.

The Scuppernong varieties, which are in greatest demand and for which the wineries pay the best prices, yield relatively small crops as compared to the James, Thomas, and other prolific sorts. An average yield of 25 to 30 bushels of Muscadine grapes per acre from 4-year-old vines, 50 to 75 bushels from 5-year-old vines, and 100 to 150 bushels from vines in full bearing should be obtained. Great variation in the yields occur, however. Inferior crops are caused by wet, cool weather at blooming time, late frosts, black-rot injury to bloom and foliage, weak old vines, lack of pruning, lack of fertilization, etc. Neverthe-

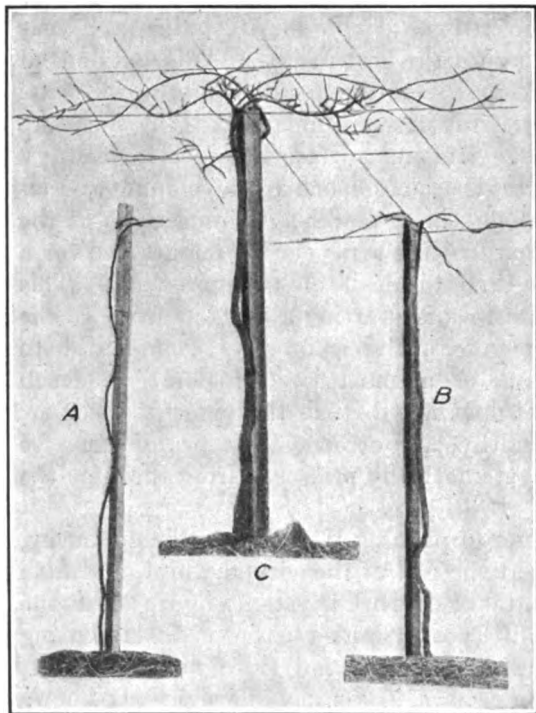


FIG. 20.—*Rotundifolia* vines trained in accordance with the horizontal or overhead system: A, End of second year; B, end of third year; C, end of fifth year.

less, Muscadine grapes are considered among the most profitable of fruits. Large yields are often secured.

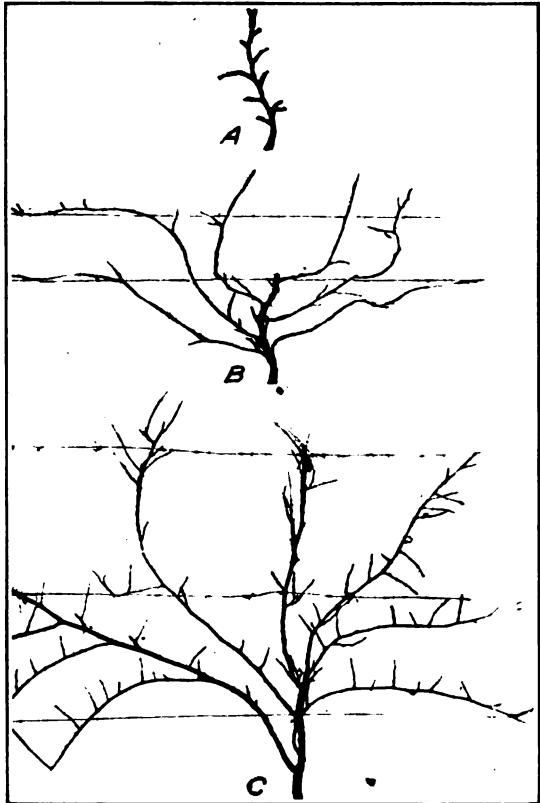
A Florida grower estimated his 1911 crop of Scuppernong and Thomas grapes at 280 bushels to the acre. The same year in eastern North Carolina a vineyard 77 years old, in which more than half the vines were Scuppernong, yielded 2.4 tons of fruit to the acre. The same season an adjacent Scuppernong and Mish vineyard about 20 years of age was said to have yielded 6 tons to the acre. In the same vicinity another grower secured from his James vineyard of 5.83 acres, 6.7 tons of fruit per acre, while his Scuppernong grape vineyard

of 5.86 acres yielded only 3.3 tons to the acre. In 1906 a North Carolina grower harvested 177 bushels of grapes to the acre from a 4-year-old James vineyard, and in addition a bale of cotton per acre was grown between the rows.

The price paid for Muscadine grapes varies somewhat with the seasons, the quality of fruit, the variety, and the condition of the market. In years of light fruit crops higher prices are paid. Hand-picked fruit of good quality, attractively packed, sells for more than similar grapes shattered from the vines. Generally, the light-colored varieties, being sought by the wineries, have sold for higher prices on the general market than the dark-colored grapes. In the past there has been considerable competition between wine makers for light-colored Muscadine grapes. In markets where the companies were competing, such grapes have brought \$3 and even more per bushel. Nothing like such prices will probably ever be paid again. It has been possible up to the present time to contract with wine makers to take all the white Muscadine grapes the grower could produce for 75 cents or better per bushel for a period of years. The

average price paid for shattered grapes for the past six or eight years has been between 85 cents and \$1 a bushel. The prices paid for Muscadine table grapes are generally higher in the larger cities than in the villages or towns of the South, owing to the supply being relatively so much less in proportion to the population.

Choice hand-picked fruit in half-bushel peach baskets or in berry boxes usually sells for \$1 to \$2 a bushel. Certain growers have built



(P16833HP)

FIG. 21.—*Rotundifolia* vines trained in accordance with the vertical radiating system: A, End of second year; B, end of third year; C, end of fifth year.

up an excellent trade for hand-picked fruit, sometimes shipping it to distant customers who are familiar with the Muscadine grapes. Under these conditions the fruit generally brings about \$2.50 per 6-basket peach crate. For such trade, of the varieties grown at present the James and Mish grapes are best suited. If sold locally, however, the Thomas and light-colored varieties are as valuable and are preferred by some customers.

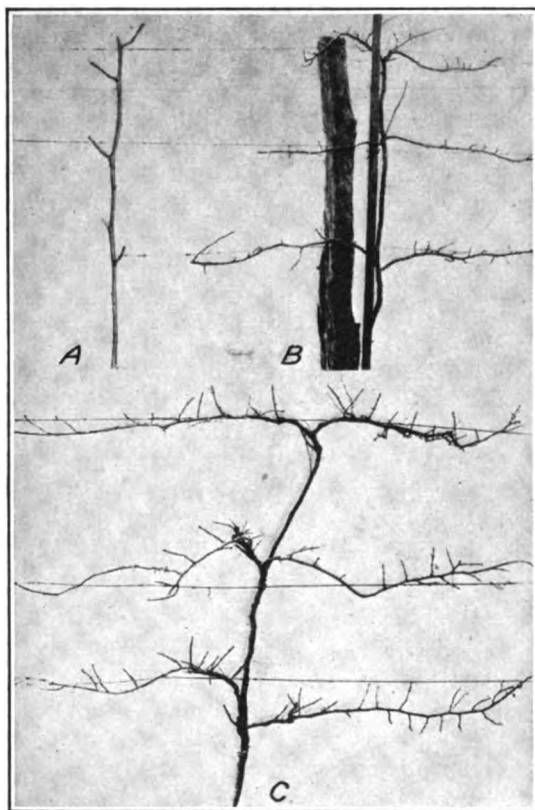
USES OF MUSCADINE GRAPES.

Muscadine grapes are principally used for wine making. There are wineries in the South, the two largest that make a specialty of Muscadine products being located at Norfolk, Va., and Wilmington, N. C., respectively. These products are of characteristic flavor and quality and are in considerable demand. Probably three-fifths of the total Muscadine-grape crop is used by the wineries.

An unfermented juice for the home can be made from Muscadine grapes. Their unfermented juices, although quite pleasant when fresh as they run from the crusher, after sterilization appear devoid of fruity flavor.

By adding sugar at the time they are used, the fruity flavor is largely restored. Unless better results than those so far obtained are to be had with them, they are not to be recommended as unfermented juices for commercial use.

As a table grape or as a fruit to be consumed fresh Muscadines are much relished, especially if eaten soon after they are picked from the vines. As most of the varieties shell from the comb when harvested, they are not generally adapted for shipping purposes. Their



(P16830HP)

FIG. 22.—Rotundifolia vines trained in accordance with the vertical 6-arm renewal system: A, End of second year; B, end of third year; C, end of fifth year.

shipment for use as fresh fruit is an undeveloped phase of the industry. All Muscadine grapes make excellent jellies, preserves, catsup, etc. The canned grapes are used in pies.

INSECT ENEMIES AND DISEASES.

Muscadine grapes are generally considered remarkably free from insect enemies and diseases. There are, however, insects and diseases found on them which, while not serious at the present time, had best be noted and observed. The most important of the diseases is the black-rot (*Guignardia bidwellii*), which so generally attacks other grape species. This disease does not affect the fruit of Muscadine as it does Euvitis varieties, but it blights the bloom buds in unfavorable growing seasons. It affects the foliage of Muscadines, as it does of Euvitis vines, by causing brick-red diseased areas in which spore cases, resembling tiny black dots, may be noted. The remedy for this disease is to spray with Bordeaux mixture. Directions for spraying may be obtained from the United States Department of Agriculture. Insects worthy of note are the grapevine flea beetle (*Haltica chalybea*) and certain unidentified snout beetles, but the injury they do is at present negligible.



(P16092HP)

FIG. 23.—Hand-picked Muscadine grapes ready for shipment.

BREEDING INVESTIGATIONS.

The United States Department of Agriculture is conducting breeding investigations with Muscadine grapes for the purpose of producing varieties that are an improvement over present sorts in one or more

of the following particulars: (1) Better adherence of berry to cluster, (2) increased size of cluster, (3) higher sugar content, (4) lower acid content, (5) improvement in pulp, (6) decreased size and number of seeds, (7) thinner skin, (8) uniform ripening, (9) self-fertility.

A large number of valuable seedlings have been produced, to which additions are made each year. These are being tested and studied and the worthless ones discarded as rapidly as possible. Some exceedingly valuable sorts have already been secured. One lot of 49 seedlings has been produced in which over 50 per cent are perfect flowered and self-fertile, and there is not a sterile male seedling in the lot. It is believed that it is only a matter of time when self-fertile varieties with greater yields than the present varieties will be produced. With such varieties the planting of male vines will be unnecessary. Marked results are being obtained along other lines of breeding. A number of hybrids between Muscadine and American *Euvitis* and between Muscadine and *Vinifera* grapes have been produced, all of which are exceedingly promising.

VARIETIES.

It is not possible to give detailed descriptions of the Muscadine grape varieties in a bulletin of restricted size. Only general descriptions of the leading varieties will be given.¹

SCUPPERNONG.

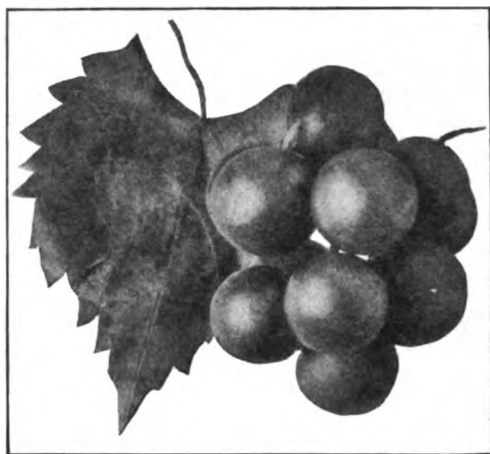
The Scuppernong is probably the oldest cultivated variety of native American grapes. While the place of origin can not positively be stated, owing to the age of the variety, it has been pretty definitely established that it originated in Tyrrell County, N. C., before 1760. From here it was soon distributed over the northeastern part of North Carolina and to Roanoke Island. In this section many large old Scuppernong vines are to be found. Many of these are known to be over 100 or 125 years of age. An old vine growing on Roanoke Island is said to have been planted by Sir Walter Raleigh and to be the original Scuppernong. Those who have investigated most closely the origin of the variety, however, adhere to the theory that the original vine grew wild in Tyrrell County, in the vicinity of the Scuppernong River.

From the vicinity of its origin the variety was distributed throughout the eastern part of North Carolina and was planted in vineyards ranging in size from a few vines to many acres. Some of these vineyards have been steadily enlarged, but many were allowed to run down. From these vineyards the variety was gradually distributed

¹ Those desiring detailed descriptions of the other known Muscadine varieties are referred to the following publication, which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 25 cents a copy: Husmann, G. C., and Dearing, Charles, *The Muscadine grapes*. U. S. Dept. Agr., Bur. Plant Indus. Bul. 273, 64 p., 26 figs., 11 pl. (1 col.). 1913.

over the Coastal Plain and Piedmont sections of the southeastern United States. It has steadily increased in popularity and is to-day the leading variety of the Muscadine grapes.

The vine is productive and vigorous, a rank grower, with long, slender, smooth, yellowish canes, covered with small light-brown dots or lenticels. It thrives best in well-drained sandy loam soils. The leaves (fig. 24) are of medium size, cordate, with the margin medium serrate. In texture the leaf is smooth and rather thin in comparison with other varieties. The cluster is small, having 1 to 15 but generally 2 to 6 berries. The berries average three-fourths of an inch in diameter, and when fully ripe vary in color from pearly green to reddish brown, depending on the amount of exposure to the sun of the individual cluster and berry. They ripen fairly early and the individual berries shatter readily from the cluster when ripe. The skin of the berry is medium tough and is covered with numerous small russet dots, and sometimes russet blotches. The flesh is pale green, juicy, soft, musky, sweet, sprightly, and of good quality. The seeds are large. This variety is suited for home use and wine making. It is productive, but not so productive as the James or Thomas.



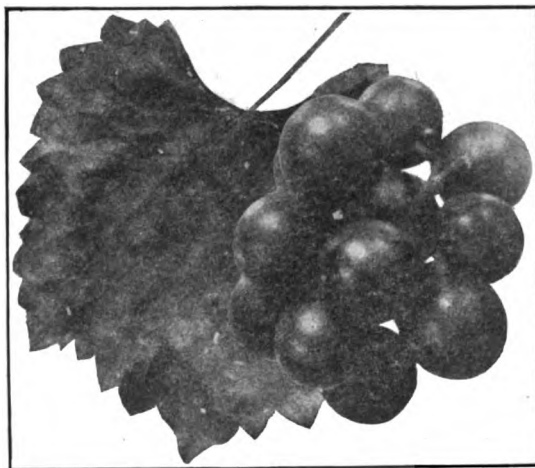
(P16828HP)

FIG. 24.—Leaf and cluster of the Scuppernong grape. (Two-thirds natural size.)

Some confusion has arisen in the past owing to the variety name, Scuppernong, having been rather loosely used. The leading Muscadine grape growers, wine makers, nurserymen, and horticulturists in the Muscadine grape district agree that the name should be applied to only the single variety of the Muscadine grapes which has just been described. The name Scuppernong is sometimes incorrectly used to designate other varieties having light-colored fruit, or all the varieties having light-colored fruit, or even all the varieties of Muscadine grapes, both light and dark. In the past, some nurserymen have sold other light-fruited varieties as the Scuppernong. Nevertheless, the variety should be kept distinct, and it is hoped that in the future nurserymen will assist in keeping it true to name by making sure that they propagate the true Scuppernong. Other light or dark fruited varieties have other names or should be given other names.

MISH.

The Mish variety (fig. 25) was discovered by Mr. Albert Mish, between 1840 and 1850, growing in pure river sand near Washington, N. C. The vine is very productive and a vigorous, rather open, slightly trailing grower. The leaves are thick, rather round, and above medium size. The cluster is of medium size, the berries adhering fairly well to the pedicel. The berries range from about eleven-sixteenths to three-fourths of an inch in diameter, are slightly ovoid, almost black, and have numerous "guinea-egg" specks. The variety ripens uniformly but late. The skin is medium thin, cracking in wet weather. The flesh is tender, juicy, and sweet. The flavor is distinct, delicious, and of fine quality. The Mish is the best all-round Muscadine grape and is esteemed next best to the Scuppernong as a wine grape.

JAMES.

(P16827HP)

FIG. 25.—Leaf and cluster of the Mish grape. (Two-thirds natural size.)

The James grape (fig. 26) was discovered about 1866 or 1867 by Mr. B. W. M. James, in Pitt County, N. C. It thrives in fine sandy loam soils with clay subsoil. The vine is very productive and a vigorous, slightly trailing grower. The leaves are cordate, nearly as broad as long, medium sized, with serrate margin; in late summer

they have a mottled yellow and green appearance. The cluster is round, containing from 2 to 12, sometimes more, but usually 4 to 6, large, round, rather glossy, bluish or deep purplish black berries when fully ripe, with pronounced, not very numerous "guinea-egg" specks. The variety is rather late in ripening, and when not fully ripe there is a characteristic reddish coloring around the pedicel. The berry is juicy and the flesh meaty. The skin is thick and rather tough. The flavor and quality are medium. The James is the all-purpose grape of the Muscadines.

FLOWERS.

The Flowers grape (fig. 27) was discovered by "Popping Billy" Flowers in 1819 growing in a sandy loam soil in Robeson County, N. C. The variety thrives in northern Florida and is said to do well as far south as the Florida keys. The vine is a very productive and

upright, slender, rather open, moderately robust grower. The leaves vary, but average medium in size, are longer than broad, pointed, cordate, thick, dark green, slick, and leathery, with the margin sharply serrate. The cluster is round, containing generally from 6 to 10 medium-sized purplish black, slightly oval berries. The Mish variety ripens late. The skin is very thick, tough, and faintly marked with dots. The flesh is white, meaty, tough, and not very juicy. The flavor is sweetish, lacks sprightliness, and is of medium quality.

THOMAS.

The Thomas grape (fig. 28) was discovered between 1850 and

1855 by Mr. Drewery Thomas, near Marion, S. C., growing in a fine sandy loam with fine clay subsoil. The vine is very productive and a vigorous, rank grower. The leaves are cordate, rather large, longer than broad, rather thick, with serrate margin. The variety ripens in

midseason. The cluster is round and small. The berries are of medium size, round, and when fully ripe of a dark wine color, and surrounding the base is a wide, prominent, irregular, greenish yellow pentagonal marking. The berries ripen unevenly and have poor adherence to the pedicel. The flesh is tender, juicy, very sweet, and has an exceptionally rich, fruity, sprightly flavor. The skin is

thin and moderately tough, with numerous pimples dotting the surface.

EDEN.

The Eden grape (fig. 29) was discovered on the premises of Dr. Guild, near Atlanta, Ga., growing in typical Piedmont red-clay soil. The



FIG. 26.—Leaf and cluster of the James grape. (Two-thirds natural size.)

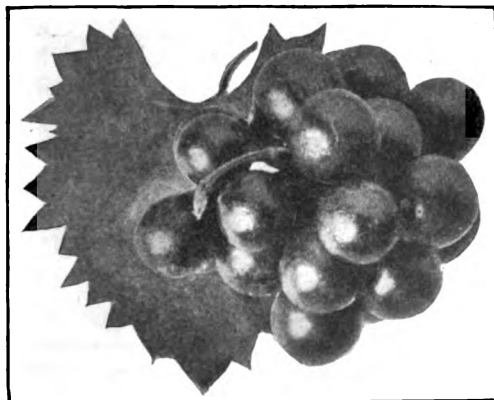


FIG. 27.—Leaf and cluster of the Flowers grape. (Two-thirds natural size.)

vine is exceedingly productive, vigorous, with dense foliage and dark-colored wood. The leaves are medium in size and thickness, rounded, with wide basal sinuses and rounded marginal teeth and blunt tip.

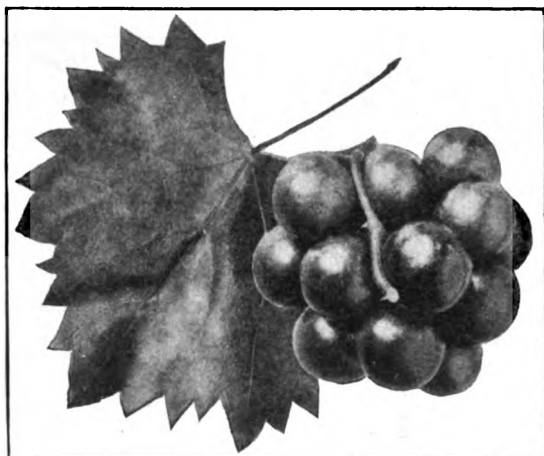


FIG. 28.—Leaf and cluster of the Thomas grape. (Two-thirds natural size.)

is very good. The skin is relatively thin and tender. It is well adapted for wine, home, and kitchen use. There are many points about the Eden suggesting that it is a natural hybrid between the *Rotundifolia* and *Munsoniana* species.

Other varieties of more or less prominence, named in the order of their estimated value, are the Smith, Memory, Luola, Hopkins, Latham, Lady James, Pee Dee, Sugar, Carolina Belle, Beula, Tenderpulp, Clayton, Westbrook, and Brown. A series of Muscadine grape hybrids produced by the late T. V. Munson is at present of interest chiefly to grape breeders.

CONCLUSION.

If, after reading this bulletin, the reader desires more specific information regarding some phase of Muscadine grape growing, the Department of Agriculture will be glad to furnish such information on application.

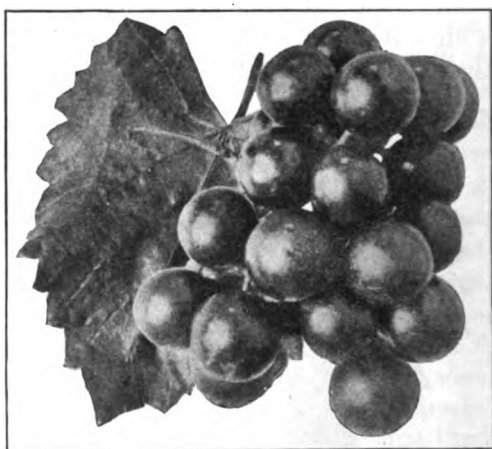


FIG. 29.—Leaf and cluster of the Eden grape. (Two-thirds natural size.)

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UNITED STATES DEPARTMENT OF AGRICULTURE



FARMERS' BULLETIN



WASHINGTON, D. C.

710

FEBRUARY 21, 1916

Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.

BRIDGE GRAFTING OF FRUIT TREES.

By W. F. FLETCHER,

Scientific Assistant, Office of Horticultural and Pomological Investigations.

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INTRODUCTION.

Numerous inquiries are received at the Department of Agriculture every spring in regard to the treatment of fruit trees, especially apple trees, that have been girdled or otherwise injured during the winter by mice and rabbits. While there are various ways in which slight injuries of this character may be treated, if any attention seems advisable, wounds which girdle or nearly girdle the trunk require more specific measures if the tree is to be saved. In such cases bridge grafting is the method of treatment commonly employed; in fact, it is about the only remedy that can be recommended.

A bridge graft is made by using scions or small limbs to connect the two portions of the bark of a stock which have been separated by an injury; in other words, the injured area is "bridged" by a scion or scions, the ends of which unite with the uninjured parts above and below the wound in such a manner that a connection between the tissues is established.

RANGE OF USEFULNESS OF BRIDGE GRAFTING.

Bridge grafting may be used successfully on almost any kind of fruit tree that admits of being readily propagated by grafting. In practice there is occasion to resort to it very much more frequently

with the apple than with any other fruit, but pear trees are often treated, at least in some sections. No reason is apparent why the method should not be successful on plums and cherries. Peaches graft less readily than the other trees mentioned, and there may be some question as to the usefulness of the method in the case of this fruit. Bridge grafting is seldom used on shade or other ornamental trees, but with some kinds it would probably prove successful in overcoming certain types of injuries.

The injuries which can be overcome or lessened by bridge grafting are always local in character and do not of themselves at the time they occur seriously affect the health and vigor of the tree either above or below the injured area. Such injuries are usually either mechanical or pathological in character.



(P12697HP)

FIG. 1.—The trunk of an apple tree as it passed through the winter, surrounded by grass and weeds. In the spring it was found to be girdled by mice below the surface of the ground.

MECHANICAL INJURIES.

Mechanical injuries which may be remedied by bridge grafting are usually inflicted in one of three ways: By animals that feed upon the bark and tender wood, by insects that burrow through the growing layer of bark and wood, or by implements used in the tillage of the orchard, usually the result of the carelessness of workmen.

The animals liable to do the most damage by girdling are the common meadow mouse, pine mouse, pocket gopher, and rabbit—the cottontail in the States east of the Great Plains and the jack rabbit westward from the range of the cottontail to the Pacific Ocean.

Most of the injury caused by these animals is done during the dormant period, when other plants on which they feed are scarce. Rabbits, however, occasionally gnaw young trees quite early in the fall, and mice, especially meadow mice, may work at almost any time under the shelter of vegetation that has been allowed to accumulate about the base of trees.

Mice and gophers work usually near the surface of the ground or snow, though sometimes the injury may extend for a short distance both above and below the surface. Some species of mice and also

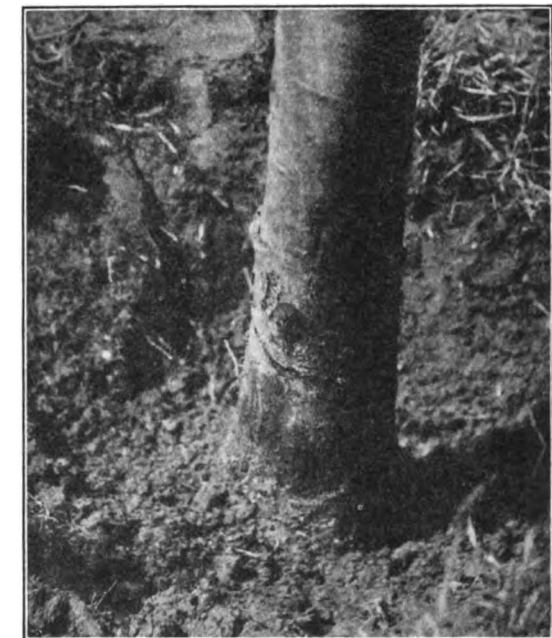
gophers may eat the small roots as well as the bark. Young trees are more apt to be attacked than older ones, but trees of mature age are sometimes seriously injured by these animals.

Where the injury is below the ground it is likely to remain unnoticed until it is revealed in the spring by the evident weakness of the tree after growth starts. If an injury is not suspected until the season is well advanced, the tree may be too far gone to be saved by any method of treatment.

A case of underground injury by mice is illustrated in figure 1, showing an apple tree as it passed through the winter surrounded by grass and weeds, which proved in the spring to have been badly girdled by mice. Figure 2 shows the same tree as figure 1, with the soil removed, thus exposing the girdled area.

Rabbits feed mostly at night, and, although they work entirely above ground, may do considerable damage, sometimes to the extent of stripping practically all the bark from the body of a tree.

Borers are the only insects which are likely to girdle the body or trunk of a tree.



(P12992HP)

FIG. 2.—The tree shown in figure 1, with the soil removed and the girdled area exposed to view.

PATHOLOGICAL INJURIES.

Local injuries may be caused by various diseases, of which pear-blight is the most common. The trunks of pear trees are not infrequently completely girdled and killed by this disease. If taken in time, however, it may be possible to cut away the diseased bark, bridge the wounded area with grafts, and thus save the tree.

Relatively large areas of bark may also be killed by what is commonly called sun scald, as well as by other troubles that are pathological or physiological in their nature. The losses from such injuries may often be greatly reduced by resorting to the method of treatment here described.

DETAILED INSTRUCTIONS FOR BRIDGE GRAFTING.

The important steps in bridge grafting are shown in figure 3. In preparing the wound to receive the grafts the injured parts should be thoroughly cleansed, all dead tissue cut away, and, if possible, the cleansed surface should be sterilized by washing it with a solution of bichlorid of mercury, copper sulphate, or some other antiseptic. The irregular edges of the bark (fig. 3, *A*) at the upper and lower margins of the wound should be cut back evenly, as shown in figure 3, *B*.

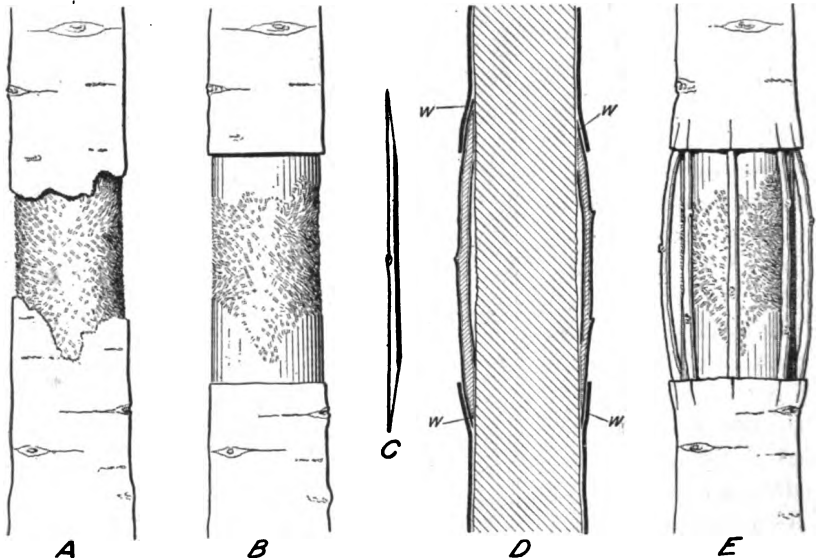


FIG. 3.—Details of bridge grafting: *A*, The trunk of a tree girdled by mice; *B*, the wound cleansed and the bark along the margins trimmed back to healthy, growing tissue; *C*, a scion with beveled ends ready for insertion; *D*, longitudinal section of the trunk with scions in place, showing their insertion under the bark of the trunk (*w*); *E*, scions in place ready for waxing.

The scions which form the bridge should be selected from wood of the previous season's growth. Either branches which grew the preceding season or water sprouts that are only a year old may be used.

It is important that the scions should be a little longer than the space that is to be bridged. This is in order that the middle portion of the scions when put in position shall arch slightly over the central part of the wound. This is illustrated in figure 3, *D*, where a longitudinal section of a bridge graft is shown.

Before being placed in position the scions are beveled at each end, both beveled surfaces being on the same side of the scion, as shown in figure 3, *C*. This beveling should be done with a long, sloping cut, so that the wedge-shaped ends thus formed will be relatively thin, to permit their being thrust well under the bark without danger

of separating it unduly from the cambium at the points of insertion. Reference to figure 3, *D*, illustrates this feature. The placing of the scions in position is facilitated if the bark at the margins of the wound is slit for a short distance at the points where the ends are to be inserted. (Fig. 3, *E*.)

The number of scions required for a bridge will depend largely upon the size of the trunk. No fixed rule can be given. The larger the number, the more nearly complete will be the restoration of the connection between the parts above and below the wound; but if placed too close together, the bark at the margins of the wound between the scions will be raised. The starting of the bark except at the immediate points of insertion of the scions must be avoided.

In placing the scions it is of the greatest importance that the cambium of the scions which is exposed in the sloping cuts at the ends be brought into intimate contact with the cambium that lies under the bark at the margins of the wounded area.

The union of scion and tree can occur only where the cambium layers of the two come together. The scions may be secured in their proper positions, if need be, by driving a small nail through each end into the trunk. This will aid in drawing the cambium of scion and trunk closely together.

The operation is completed by thoroughly covering the area occupied by the ends of the scions and the margins of the wound with grafting wax, strips of waxed cloth, or by some other means that will adequately prevent these parts from drying out. The use of wax for this purpose is illustrated in figure 4. Some operators cover the entire wound, scions and all, with melted wax.



(P12999HP)

FIG. 4.—The tree shown in figures 1 and 2, with the scions which form the bridge in place. As the injury extended some distance down a root on the right, relatively long scions were used on that side. Grafting wax has been applied to the ends of the scions and margins of the bark, to prevent drying out.

If the wound is mostly below the surface of the ground, as shown in figures 1 and 2, very good results can be obtained by burying the injured parts in a mound of earth after the bridge grafting has been completed, as shown in figure 5. This treatment partially excludes the air and aids in preventing undue drying out of the injured parts.

A bridge graft 3 years old, made to save a pear tree girdled by blight, is shown in figure 6. The diseased tissue was cut away before the bridging was done.

Another method of bridging a badly wounded area is suggested in figure 7, which shows a pear tree girdled by blight. The diseased bark and cambium have been cut away, thus making a wound so



(P12689HP)

FIG. 5.—The bridge graft shown in figures 1, 2, and 4 completed and entirely covered with earth.

large that ordinary bridge grafting is impracticable. Several 2-year-old pear trees have been planted about the base of the injured tree, and their tops grafted into its trunk above the girdled space. As the tops of the small trees are too large to manipulate readily in the manner described for scions, V-shaped vertical grooves extending through the cambium are cut just above the wounded area in the bark of the tree to be treated.

The tops of the small trees are shaped to

correspond with these grooves. The two are then accurately fitted together in such a manner as to bring the cambium of one into contact with that of the other. Small nails may be driven through the tops of the trees into the trunk, to hold the parts firmly together. The wounds incident to joining the tops of the small trees to the trunk of the large one should be well covered with wax, to prevent drying out. In the case illustrated in figure 7 a cord has been tied around the trunk, to aid in holding the tops of the young trees in proper position.

This method has been employed with success for several years in at least one important pear-growing district of the Northwest, and

it is referred to in this connection because of its possible value in other sections.

To be effective, bridge grafting should be done in the spring before growth starts, though sometimes it can be done after growth starts if dormant scions for that purpose can be secured.

PREVENTION OF INJURIES.

While the bridging of a wound by grafting is comparatively easy the use of preventive measures, so far as they are effective, is much easier. Weeds and rubbish about the trunk of a tree are likely to attract mice, as they furnish both a desirable nesting place and a food supply. By clearing away upon the approach of cold weather



(P11212HP)

FIG. 6.—A bridge graft 3 years old, made to save a pear tree that had been girdled by blight. The diseased parts were cut away before the bridging was done.

the grass and aftergrowth that has accumulated near the trees, the danger of injury from mice is greatly reduced.

Wherever rabbits are likely to gnaw the bark from young trees—and they work, as a rule, only in comparatively young orchards—adequate protection may be afforded by placing wire netting or wooden-veneer protectors about the trunks, or even by wrapping them with several thicknesses of newspaper. The latter



(P11262HP)

FIG. 7.—A pear tree badly girdled by blight. Several 2-year-old pear trees have been planted about the base of the injured tree and their tops grafted into the trunk of the older tree.

method is practicable where the number of trees is limited. A more convenient way, however, and one reported to be effective, is to keep the trunks well covered during the winter with a lime-sulphur mixture.

If trees are carefully examined two or three times each season for borers and proper measures are adopted for destroying them, serious losses from such insects may usually be prevented.

Further information in regard to the control of the animals and insects which are likely to girdle trees may be found in the publications listed below.

PUBLICATIONS OF THE DEPARTMENT OF AGRICULTURE RELATING TO ANIMALS AND INSECTS THAT ARE LIKELY TO GIRDLE TREES.

AVAILABLE FOR FREE DISTRIBUTION.

Field Mice as Farm and Orchard Pests. Farmers' Bulletin 670.

The Roundheaded Apple-Tree Borer. Farmers' Bulletin 675.

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS.

The Peach-Tree Borer. Entomology Circular 54. Price, 5 cents.

The Rabbit as a Farm and Orchard Pest. Separate 452, Yearbook, 1907. Price, 5 cents.

Pocket Gophers as Enemies of Trees. Separate 506, Yearbook, 1909. Price, 5 cents.

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UNITED STATES DEPARTMENT OF AGRICULTURE



FARMERS' BULLETIN



WASHINGTON, D. C.

711

MARCH 22, 1916

Contribution from the Forest Service, Henry S. Graves, Forester.

THE CARE AND IMPROVEMENT OF THE WOOD LOT.

By C. R. TILLOTSON, *Forest Examiner.*

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INTRODUCTION.

Wood grown in the farm wood lot is a farm crop. That it is, however, is too often overlooked; because, unlike other farm crops, timber requires a small amount of labor and a long period of years to bring it to a marketable condition. If properly cared for, a wood lot will furnish material for market at intervals, and will afford a supply of timber, fuel, etc., for home use at all times. If neglected or abused, it is bound to deteriorate, and may eventually disappear altogether. The aim of this bulletin is to point out methods of caring for the wood lot and improving it so as to make it produce the largest and best crop of which it is capable.

ESSENTIALS OF A GOOD WOOD LOT.

The wood-lot crop, like any other, should be judged by its quantity and quality. To secure a full stand of trees of high quality, therefore, should be the farmer's aim. Fortunately, the quality of timber is very largely determined by how dense the stand is; that is, how close together the trees are. To be of high quality, timber

must be, to a considerable proportion of its height, free of limbs, which are the cause of knots; it must be tall; and it must not decrease rapidly in diameter from the butt to the top of the last log. In a dense stand of timber there is considerable competition for sunlight among the individual trees, with the result that height growth is increased. Trees in crowded stands are taller than those in uncrowded stands of the same age. When the trees are crowded so that sunlight does not reach the lower branches, these soon die and become brittle; they then fall off or are broken off by the wind, snow, or other agencies. By this process trunks are formed which are free of limbs, and hence of high quality. Further, when trees are crowded their diameters do not decrease rapidly from the butts to the tops. In uncrowded stands just the opposite is true: height growth is less; the lower branches continue to live, increase in size, and form large knots; and there is a much greater taper in the trunks of the trees. It is evident, therefore, that trees in the wood lot should be so crowded that the crown or top of each individual tree may be in contact with those of its nearest neighbors. A crowded stand of trees produces not only a larger number but also a greater proportion of high quality sawlogs than an uncrowded stand of an equal area. This is of vital importance, because the price of logs of first quality is usually from one and one-half to two times as much as that paid for logs of poor quality.

STOCKING.

The approximate number of trees which should be present per acre is given in Table 1. The figures are applicable to oak, aspen, hickory, elm, and ash, but are from 15 to 20 per cent too low for maple, basswood, yellow birch, beech, and white or red pine.

TABLE 1.—*Number of trees which should be present per acre.^a*

Diameter. ^b	When diameter of trees ranges from—				When trees are all of a uniform diameter.
	2 to 10 inches.	2 to 14 inches.	6 to 18 inches.	10 to 24 inches.	
<i>Inches.</i>	<i>Trees.^c</i>	<i>Trees.^c</i>	<i>Trees.^c</i>	<i>Trees.^c</i>	<i>Trees.^c</i>
2.....	400	300			2,000
4.....	180	130			900
6.....	105	75	75		510
8.....	65	45	45		390
10.....	50	30	30	30	235
12.....		25	25	20	170
14.....		20	20	16	130
16.....			15	12	100
18.....			12	11	85
20.....				9	75
22.....				8	65
24.....				7	55
Total per acre....	800	625	222	113	.....

^a Data furnished by Prof. E. L. Sponsler, University of Michigan.

^b Diameters taken at 4½ feet from the ground.

^c Of the respective diameters indicated in the first column.

SPECIES.

From the marketing standpoint, some species are preferable to others. Black walnut, white oak, and yellow poplar, for instance, are now of more value than basswood, red gum, or beech. It is probably best, however, to grow in the wood lot those species which will produce the largest amount of material within a specified time rather than to attempt to grow the species most valuable now. This means that trees of the most rapid growth which are well adapted to the region and situation and not subject to serious insect or fungous¹ attacks should be favored. By regions the most prevalent species in the wood lot are:

1. Northern Michigan, Wisconsin, and Minnesota: White, jack, and red pines, aspen, yellow birch, basswood, scarlet, black, and red oaks, white ash, elm, hemlock, hard maple, and beech.

2. Southern Michigan, Wisconsin, Minnesota, and northern Indiana: Red, white, and black oaks, white ash, basswood, elm, hickory, maple, and beech.

3. Southern Indiana, Illinois, southeast Missouri, western Kentucky, and western Tennessee: Yellow poplar, black walnut, red gum, white oaks of several species, black oak, red oak, cottonwood, red elm, hickory, white ash, beech, and maple.

4. Eastern Kentucky and Tennessee: Yellow poplar, white ash, red oak, black walnut, black cherry, chestnut, chestnut oak, white oak, red oak, hickory, white pine, and shortleaf pine.

5. Ozark region of Missouri: Shortleaf pine, black oak, walnut, red cedar, several species of white oak, and black jack oak, red elm, and hickory.

6. Ohio: Yellow poplar, white ash, basswood, red and black oaks, walnut, white oak, red elm, hard maple, beech, and hickory.

7. New England: White pine, red spruce, hemlock, arborvitæ, white cedar, balsam fir, chestnut, red and black oaks, hard maple, red maple, beech, yellow birch, paper birch, gray birch, black birch, aspen, tulip poplar, white ash, elm, basswood, and hickory.

8. North Atlantic States: White pine, hemlock, arborvitæ, white cedar, balsam fir, pitch pine, chestnut, red, white, and black oaks, hard maple, red maple, beech, yellow birch, black birch, tulip poplar, white ash, cucumber, black gum, elm, basswood, and hickory.

9. South Atlantic and Southern States: Loblolly, shortleaf, longleaf, and scrub pines, cypress, white, black, and red oaks, black walnut, tulip poplar, white ash, red, black, and tupelo gums, beech, and hickory.

The comparative rates of diameter growth of the most important of these species for which data are available are about as shown in

¹ Chestnut is of rapid growth but is subject to such serious fungous attack (chestnut blight) that it should be supplanted by other species.

Table 2. For the rate of growth in any specific locality, Table 3 should be examined.

TABLE 2.—*Comparative rates of diameter growth of trees.*^a

Average number of years to grow 1 inch in diameter.	Species.
2 years.....	Cottonwood.
3 to 4 years.....	Yellow poplar, red gum, loblolly pine.
3 to 5 years.....	Shortleaf pine, black locust, chestnut, bald cypress, scrub pine.
4 to 7 years.....	Black walnut, white pine, red pine, white ash, red oak, black oak, aspen.
6 to 9 years.....	Hickory, white oak, chestnut oak, post oak, burr oak, basswood, paper birch.
8 to 10 years.....	Red spruce (second growth).
9 to 18 years.....	Hard maple, yellow birch, beech, white elm, hemlock, balsam fir.
18 to 25 years.....	Arboreal.

^a Table is based on growth of trees in natural unmanaged stands. Under proper management, much more rapid growth can be secured, particularly of those species in the last four lines.

The slower growing species, particularly those in the last four lines, will not reach merchantable size as soon as the others, and from an investment standpoint should not be favored in the young growth, provided some of the more rapid-growing kinds will succeed on the wood-lot site. The value of these slow-growing species for farm purposes, however, will often make it equally desirable to encourage the growth of at least a few of them if the owner wishes material particularly fitted for his own farm uses.

IMPROVEMENT, CARE, AND PERPETUATION.

By far the greater number of farm wood lots are in need of improvement. Poorer species are in the majority and are crowding out the better ones, many of the trees are overmature, some show evidence of insect or fungous attack, some are dead, young trees are entirely wanting in the open places, and grazing is allowed to the extent of damaging the older trees and preventing reproduction. Improvement of these conditions can be secured through the judicious use of the axe, by assisting natural reproduction, by the exclusion of stock at least from portions of the wood lot, and, where necessary, through planting or sowing. Nearly every individual wood lot presents its own specific problem for solution in these respects, and it is impossible to do more in a publication than to indicate some of the general features which should be considered. More detailed advice can be given only when exact conditions for individual cases are known.

There are two general types of wood lots, each of which requires a different method of handling: (1) Wood lots which are characterized by the presence of old trees which dominate the stand, and (2) wood lots which are made up of a nearly even-aged stand of second growth.

1. Wood lots characterized by the presence of old trees which dominate the stand,

TABLE 3.—Average growth of various species in different regions.

Species.	Region.	Age.													
		20 years.		30 years.		40 years.		50 years.		60 years.		80 years.		100 years.	
		Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.
Aspen.	Maine.	2.4-5.3	17-40	3.6-8	28-55	4.7-10.4	39-66	5.8-12.7	50-75	7.0-14.8	57-81	9.3-19.2	64-87	11.7-23.3	66-89
Arbutus.	Minnesota.	4.7-8	47-87	5.7-11	57-111	6.7-13.3	67-111	7.7-14.9	77-111	8.7-16.5	87-111	9.7-18.1	97-111	10.7-20.1	107-111
Ash, white.	New York (good soil).	4.5-8.2	34-52	7.1-12.2	47-67	9.4-15.3	57-75	11.2-17.7	65-79	13.1-19.6	71-81	16.5-22.8	81-83	19.7-30.5	92-107
Do.	Ind. (fair to poor upland).	1.6-2.5	17-34	2.5-4.1	26-45	3.5-5.9	34-54	4.5-8.2	41-62	6.0-10.9	47-68	8.0-13.4	53-78	10.0-17.6	62-79
Ash, green.	S. Carolina (bottom land).	4.9-9.4	41-57	7.1-12.8	52-69	9.1-15.7	62-79	11.0-18.5	67-87	12.9-19.9	78-95	16.4-25.9	92-107	19.7-30.5	105-117
Do.	Arkansas (bottom land).	4.9-9.4	31-47	7.4-11.4	45-67	9.7-14.6	57-71	11.7-17.4	67-87	13.5-19.9	78-95	17.0-24.2	92-107	20.1-28.1	105-117
Do.	Michigan and Wisconsin.	2.2-3.3	23-32	3.6-5.1	34-44	5.0-6.9	43-54	6.5-8.8	52-63	7.9-10.7	59-70	10.9-14.3	71-80	13.8-17.6	78-85
Basswood.	Michigan.	7-13	13-19	1.5-2.3	21-28	2.3-3.3	28-35	3.0-4.4	32-42	3.8-5.4	39-48	5.4-7.5	48-59	7.1-9.6	57-68
Do.	New York.	1.0-1.7	10-16	1.5-2.3	14-23	2.0-2.7	18-30	2.5-3.4	22-36	3.1-4.1	26-41	4.0-5.4	33-52	5.4-7.5	57-68
Birch, yellow.	Michigan and Wisconsin.	1.1-2.1	20-30	1.7-3.3	26-39	2.3-4.6	31-48	3.0-5.8	37-54	3.8-7.1	43-60	5.0-9.8	53-68	7.7-12.5	62-73
Do.	New York.	1.8-2.6	14-22	2.6-4.1	19-31	3.5-5.9	24-40	4.5-7.7	29-47	5.4-9.4	33-53	7.4-12.8	39-64	9.4-17.6	46-74
Cedar, red.	Alabama (open stand).	3.9	19.6	6.9	27.1	9.3	33.4	11.2	38.4	12.8	41.6	15.6	53.6	18.8	62.4
Do.	New York (forest grown).	1.3	13.0	2.7	23.2	4.4	33.4	6.5	42.2	8.9	51.6	13.9	58.6	19.8	73.6
Do.	New York (forest grown).	1.9	17.0	2.8	27.0	4.4	33.4	6.5	42.2	8.9	51.6	13.9	58.6	19.8	73.6
Chestnut.	Maryland (sprouts).	6.8	47	9.3	57	11.4	69	13.4	77	15.1	83	18.0	90	20.1	91
Do.	Maryland (from seed).	3.4	17	6.0	33	8.7	52	11.2	64	13.4	73	17.2	84	20.1	91
Do.	East Tenn. (from seed).	3.1	36-55	5.6	46-71	8.2	52-84	11.1	57-92	13.7	61-98	18.4	66-107	21.7	91
Do.	East Tenn. (cove type).	2.5	20	4.8	33	7.2	46	9.4	64	11.4	73	14.5	84	16.9	91
Do.	East Tenn. (slope type).	2.4	20	6.4	33	9.5	52	12.6	77	15.6	91	18.4	107	21.7	91
Do.	Connecticut.	3.4	20	6.4	33	9.5	52	12.6	77	15.6	91	18.4	107	21.7	91
Do.	West Va. (slope type).	2.4	20	4.3	33	6.4	46	8.4	64	10.4	73	14.4	84	16.9	91
Do.	New York.	4.9	30	7.2	46	9.4	64	11.4	73	12.9	84	15.6	91	18.2	91
Cottonwood.	Mississippi Valley.	12.3	97	17.4	115	22.0	127	26.5	136	28.2	141	33.5	151	37.6	161
Do.	South Carolina.	12.6	100	17.7	118	22.1	128	26.6	137	28.3	142	33.6	152	37.7	162
Bald cypress.	Louisiana.	5.2-8.1	31-45	8.1-12.2	43-61	10.8-15.9	54-75	13.3-19.2	65-86	15.8-22.2	74-97	18.3-25.2	82-104	21.3-28.3	92-114
Do.	Maryland.	3.5-10.0	22-44	6.2-14.2	33-58	8.7-17.6	46-71	11.1-20.5	60-82	13.3-23.2	72-91	15.8-25.2	82-104	18.3-28.3	92-114
Elm, white.	Michigan and Wisconsin.	9-2.8	21	1.7-4.3	28	2.5-5.7	34	3.3-7.0	41	4.1-8.2	45	5.7-10.4	53	7.3-12.6	61
Do.	New York.	3.6-5.9	24-39	5.2-8.4	37-57	7.9-12.5	41-62	9.2-14.2	45-65	11.5-17.6	53-74	13.8-20.9	61-82	16.1-23.2	73-94
Fir, balsam.	do.	1.0-1.3	14-22	1.8-2.6	25-42	2.8-4.1	36-55	3.8-5.4	45-63	4.9-6.5	52-69	6.5-8.2	63-78	8.9-10.7	91
Do.	Maine.	1.1	14	2.2	25	4.1	36	5.5	45	6.7	52	8.2	63	10.7	111
Gum, red.	South Carolina.	7.9	39	11.2	52	14.2	61	16.8	73	19.2	84	23.4	94	26.8	104
Do.	Missouri.	3.8	24	6.3	39	9.2	52	12.2	61	15.1	73	18.1	84	21.1	94
Hemlock.	Michigan.	0.7-2.0	8-18	1.3-3.9	12-21	2.1-5.7	16-42	2.9-7.6	20-53	3.8-9.4	25-62	5.7-12.8	35-76	7.8-16.1	44-85
Do.	Southern Appalachians.	2-2.4	(?)	3.9-6.7	9-41	1.3-9.0	11-53	1.9-11.2	14-63	2.4-13.1	17-71	3.6-16.9	24-86	4.9-20.6	31-98
Do.	New York.	4-1.5	7-17	9-2.9	10-28	1.4-4.4	13-39	1.9-5.9	16-49	2.6-7.4	20-58	4.0-10.5	28-73	5.6-13.8	36-94

e Diameter on stump.

TABLE 3.—Average growth of various species in different regions—Continued.

Species.	Region.	Age.											
		20 years.		30 years.		40 years.		50 years.		60 years.		80 years.	
		Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.
		Inches.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.	Feet.
Hickory.....	New York.....	3.6	5.4	5.4	7.1	7.1	8.6	10.0	58	12.5	69	15.7	80
Mockernut.....	Ohio Valley.....	2.6	4.3	4.3	6.0	6.0	7.7	9.3	70	10.0	70	11.6	80
Pignut.....	do.....	1.8	3.1	2.9	4.1	4.1	5.3	6.5	58	9.0	69	11.6	80
Shagbark.....	do.....	1.7	2.9	4.0	4.1	4.1	5.3	6.5	58	9.0	69	11.6	80
Pignut.....	{ Northern Kentucky and	2.0	3.2	3.2	4.4	4.4	5.5	6.8	58	10.0	69	11.6	80
Shagbark.....	{ southern Indiana (fair	2.8	4.0	4.0	5.4	5.4	6.8	8.0	58	10.0	69	11.6	80
Bitternut.....	{ to good soil second	4.0	24	4.0	40	4.0	52	11.4	68	10.5	70	11.6	80
Pignut.....	{ Northern Kentucky and	3.8	31	5.5	43	7.0	52	8.5	59	10.5	70	11.6	80
Shagbark.....	{ southern Indiana (cop-	4.1	26	6.3	38	7.4	46	8.6	54	10.5	70	11.6	80
Locust, black.....	{ pley; red clay soil).	5.2	7.1	7.1	8.7	8.7	10.7	11.3	61	12.4	83	14.4	83
Do.....	Kentucky (close stand).	6.0	9.0	9.0	10.7	10.7	12.7	13.8	61	14.7	83	16.4	83
Do.....	Kentucky (broken stand).	9.3	10.7	10.7	12.7	12.7	14.7	15.8	61	16.4	83	18.4	83
Maple, sugar or	Kentucky (open stand).	6.5-1.2	10-18	1.2-2.3	19-29	1.9-3.6	25-39	2.7-4.9	32-48	3.5-6.3	38-55	5.2-9.1	49-67
Do.....	Michigan and Wisconsin.	1.3	12-26	1.9	19-37	2.7	23-46	3.5	28-53	4.3	32-58	6.0	41-68
Do.....	New York.....	4.0	29	6.8	40	9.5	51	11.3	61	12.4	70	14.2	83
Oak black.....	Tennessee (ridge).....	3.8	6.6	6.6	9.3	9.3	11.3	11.3	61	13.0	70	14.7	83
Do.....	Tenn. (cove and slope).	4.4	6.9	6.9	9.4	9.4	11.3	11.3	61	13.0	70	14.7	83
Do.....	Kentucky (upland and	4.4	6.9	6.9	9.4	9.4	11.3	11.3	61	13.0	70	14.7	83
Do.....	bottom).	4.4	6.9	6.9	9.4	9.4	11.3	11.3	61	13.0	70	14.7	83
Do.....	Southern Appalachians	4.9	38.3	6.1	47.4	6.2	53	6.7	53	7.7	58	8.2	63
Do.....	(sprouts):	5.4	48.0	7.1	59.0	7.1	59.0	7.1	59.0	8.2	63	8.2	63
Do.....	Ridge.	2.6	4.4	4.4	6.2	6.2	7.7	7.7	58	8.2	63	8.2	63
Oak, black and	Slope.	2.6	4.4	4.4	6.2	6.2	7.7	7.7	58	8.2	63	8.2	63
scarlet.	Missouri (seedling).....	2.2	3.8	3.8	5.3	5.3	6.7	6.7	58	8.2	63	8.2	63
Do.....	New York (seedling).....	3.4	4.9	4.9	6.2	6.2	7.7	7.7	58	8.2	63	8.2	63
Do.....	New York (sprouts).....	3.4	4.9	4.9	6.2	6.2	7.7	7.7	58	8.2	63	8.2	63
Oak chestnut.....	Tennessee (ridge).....	0.7-0.9	29	1.0-1.9	40	2.5-2.9	47	3.4-4.2	53	4.3-5.1	58	6.1-7.4	63
Do.....	Tennessee (cove).....	1.7	2.7	2.7	3.4	3.4	4.3	4.3	53	5.4-5.8	58	6.1-7.4	63
Do.....	Tennessee (slope).....	1.2	2.4	2.4	3.4	3.4	4.3	4.3	53	5.4-5.8	58	6.1-7.4	63
Do.....	Tennessee (ridge).....	1.7	2.7	2.7	3.4	3.4	4.3	4.3	53	5.4-5.8	58	6.1-7.4	63
Do.....	New York (sprouts).....	3.9	5.3	5.3	6.6	6.6	7.6	7.6	58	8.4	63	8.4	63
Oak red.....	North Carolina (slope).....	1.5	2.8	2.8	4.4	4.4	5.9	5.9	58	7.5	63	7.5	63
Do.....	Tenn. (cove and slope).....	3.6	32	6.9	46	10.3	60	12.7	72	14.1	80	15.5	80

In this type the old trees may almost totally exclude the younger growth, or they may exist only as a few scattered individuals throughout the stand. Such material is very likely to be deteriorating in quality, and the problem is that of removing it, and at the same time providing for a new stand of seedlings. From the standpoint of strict business management timber when mature should be cut just the same as wheat or oats; and usually this is also desirable for the good of the wood lot itself. No dead or diseased timber should under any circumstances be allowed to stand. The first operation necessary then, in wood lots of this type, is the cutting out at once of the dead and diseased material. The second is to cut the mature living trees as soon as sufficient reproduction is started in the openings and marketing conditions permit a satisfactory sale. Heavy stands composed almost wholly of mature trees should not be removed all at once unless the owner expects to provide for the new crop by planting.

To secure natural reproduction the old stand will normally have to be removed in two or three cuttings, each taking from one-third to one-half of the trees. The first cutting is designed to open up the crown cover somewhat, so that the leaves on the forest floor may decompose more rapidly, the mineral soil become exposed, and the germination of seed be more certain. The remaining trees become more windfirm, and as a result of their crowns receiving more sunlight they produce more seed. When the forest floor is in good condition the second cutting can be made during the winter following a heavy seed year. With the removal of these trees the conditions will be favorable for the germination of the seed and growth of the seedlings. Neither of the first two cuttings should be so heavy that abundant light will reach the ground and encourage a heavy growth of weeds or grass. The third cutting should be made after the seedlings are well established and no longer in need of the protection of the old trees.

In wood lots where the stand of old trees is not dense and reproduction is already well started, the older trees should be cut as soon as practicable. Unless removed these will suppress and kill out young trees which would eventually be highly valuable.

2. Wood lots which are made up of a nearly even-aged stand of second growth.

In this type of wood lot, trees of undesirable species may predominate in the stand and may be crowding out the better ones; the whole stand may be overcrowded; or it may be understocked and not reproducing. The improvement of such wood lots may be brought about by various cuttings, known as "improvement cuttings," and by practices discussed under the heading "Methods of regeneration."

IMPROVEMENT CUTTINGS.

Any cutting designed to remove a portion of the trees in a stand for the benefit of the remainder is called an "improvement cutting." When made in stands of seedlings or small saplings, such cuttings are for convenience designated as "cleanings"; when made in somewhat older stands they are known as "thinnings"; when made in stands where scattered old trees are suppressing valuable young growth, they are known as "liberation cuttings."

CLEANINGS.

Often in young stands some of the less valuable species, such as ironwood, threaten to overtop, crowd out, or damage the more valuable species, such as white ash or tulip poplar; sprouts sometimes arise too thickly from the stump of trees recently cut; or the reproduction of good species is too dense. In any of these cases some of the trees should be removed. Cleanings are nothing more than the weeding out of the poorer species or the poorer individuals where these interfere with the better ones. The practice of lopping the tops of the inferior species rather than cutting them off near the ground level can be followed. These trees will then continue to live, force the growth of the better species, and still continue to shade the ground. Both to decrease costs and to avoid overcutting, only those inferior trees which are actually interfering with the better ones should be removed. The material cut out is usually too small to pay for the expense involved. The justification for cutting it lies in the bettering of the remaining stand.

THINNINGS.

In from 15 to 20 years young stands ordinarily reach a condition which makes the cutting out of some of the trees advisable. By thinning, the stand of trees that is to form the final crop can be regulated and improved. The principle is the same as that applied by truck gardeners or orchardists who thin out their crops to secure the best development of a portion rather than a poor development of the whole. By crowding at the beginning, trees of high commercial quality are produced; but if crowding is allowed to continue after the lower branches die, it will cause a stagnation both in diameter and height growth.

The presence of dead or dying trees in the stand, a very dense interlocked crown cover, stems very slender in proportion to their height, or an apparent stagnation in the height growth indicates that a thinning is needed. Unless the condition of the stand makes earlier thinning desirable, the best practice is to defer the first one until the product is merchantable and of sufficient size to pay for the operation. Thinnings should be repeated as often thereafter as the material has accumulated in sufficient quantity again to pay for the cost. Cordwood and post material will ordinarily be obtained from the first

thinnings, and larger sized material from the later ones. In small wood lots, thinnings may be carried on by the owner at odd times at no cost other than his own labor. When poles are cut for some farm use, a little care in their selection looking to the betterment of the stand will insure a crude form of thinning.

As a rule, trees of the least prospective value should be removed. In any young stand, the trees may be assigned to several classes according to the position of their tops or crowns—dominant, codominant, intermediate, suppressed, and dead. Dominant trees are the tallest ones, whose tops receive almost complete sunlight; codominant trees are those of slightly less height with relatively narrow tops which are not fully exposed to sunlight; intermediate trees are considerably smaller than those of the first two classes, but still healthy because their tops continue to occupy open spaces in the canopy; suppressed trees are those hopelessly behind in height growth and which will either be killed by the shade of the other trees or continue to exist only as stunted individuals. The trees which remain after a thinning should, as a rule, be those which are of the best form regardless of species, the most rapid growing, and presumably of the highest final market value. The trees to be removed should, accordingly, be principally the dead ones and those of the least valuable and the most slowly growing species in the suppressed and the intermediate classes; but insect and fungous infected specimens of all classes should by all means be taken out. In order to obtain a proper opening of the crown canopy, some of the dominant and codominant trees may also have to be cut. In thinning, it must be remembered that the health and vigor of the forest trees is very much influenced by the condition of the soil. The soil should be kept fresh, soft, loose, and free of a mat of grasses. With field crops, this condition is attained by cultivation. In wood lots it must be secured by keeping the ground shaded. In making thinnings, therefore, it is desirable to retain any of the intermediate or suppressed trees which are necessary for shading the ground.

The extent to which the crown canopy of a stand may be opened depends largely upon the rate of growth of the trees and their demands for light. In general, openings should not be so large that they will not close again within from three to five years through the growth of the remaining tree tops. In stands of rapid-growing trees, such as cottonwood, tulip poplar, or red gum, the crown canopy of the dominant class of trees can be opened to a greater extent than in stands of slower-growing species, such as white oak, ash, basswood, etc. Definite rules in regard to the amount of material to be removed are not possible for all conditions, but probably not more than from one-fifth to one-fourth of the trees should be removed at a time.

The returns from thinnings will depend largely upon the market for the material removed. If the material is small and suitable only for a

poor class of cordwood, it is quite likely that the product will not pay for the cost of the operation. It must be remembered, however, that the increased growth and value of the remaining product will fully offset this cost. The material taken out in thinnings can accordingly be considered as net gain. Where the market is good, as in parts of the New England States, thinnings have been made at a net profit of from 10 cents to \$2 per cord,¹ and in one 8-acre wood lot of white pine in Connecticut thinnings netted the owner \$44.32 per acre.² When the thinning removes material suitable for posts, handle material, hub stock, small piling, or ties, the operation undoubtedly will pay for itself.

LIBERATION CUTTINGS.

Scattered old trees suppressing valuable young growth will often be found in those wood lots which have been formed by the seeding up by adjoining trees of an area such as a worn-out pasture. The first trees to start often have an abundance of room and consequently form very branchy stems and wide, spreading crowns. Such trees will never be of much value for lumber and their wide spreading habit often results in the suppression and killing of younger and better formed seedlings or saplings which ultimately would be of considerable value if the conditions were more favorable. (See fig. 1.) It is best in such cases to remove the old trees at once. A very similar condition is also found in wood lots which are the remnants of virgin stands. Scattered old virgin trees remain which, through shading, are hindering the growth of younger trees. Often these older trees, because they at one time grew in a dense stand, have a high commercial value. They should be removed as soon as a satisfactory sale can be arranged.

CUTTING OUT OF VINES.

Such vines as grape, ivy, and woodbine sometimes occur in wood lots and almost invariably twine about the trunk and throughout the tops of the trees. They affect both conifers and hardwoods and often do more damage than may be commonly realized. When of large size, their heavy foliage and small branches shade out and kill the leaves of the trees. Also by their sheer weight alone they often bend over the tops of the trees, which are thus either killed or rendered very unthrifty. (See fig. 2.) The vines themselves have no special value, and they should accordingly be eliminated by severing the parent stem near the ground. It will be best to carry on this operation while the vines are yet small and before they have done any appreciable damage; and, if lack of time prevents a thorough job, at least the larger ones which it is readily apparent are doing harm should be cut out.

¹ Bulletin No. 2, State Forester's Office, Mass. 1905.

² "Economic Thinnings of White Pine," Forestry Quarterly, Vol. V, 1907.

PASTURING OF WOOD LOTS.

Pasturing of wood lots has been one of the chief causes of their deterioration. The severity of the damage depends largely upon the number of stock and the size of the wood lot. One characteristic



FIG. 1.—Large spreading tree of poor timber form in center is interfering with thrifty young trees surrounding it and should be cut out.

of a heavily pastured wood lot is the almost complete absence of young growth, or its existence only in small ragged patches as broken or scrubby stuff. Cattle, horses, sheep, or goats eat young seedlings, particularly the hardwoods, trample them out, or brush against them and break them off. Hogs eat the seed and thus prevent reproduc-

tion from starting, or root young seedlings out of the ground, and sometimes eat the roots. (See figs. 3 and 4.)

The old growth is damaged through trampling and wounding of the roots, and through compacting the soil to such an extent that it is almost impervious to water. Horses sometimes peel the bark from

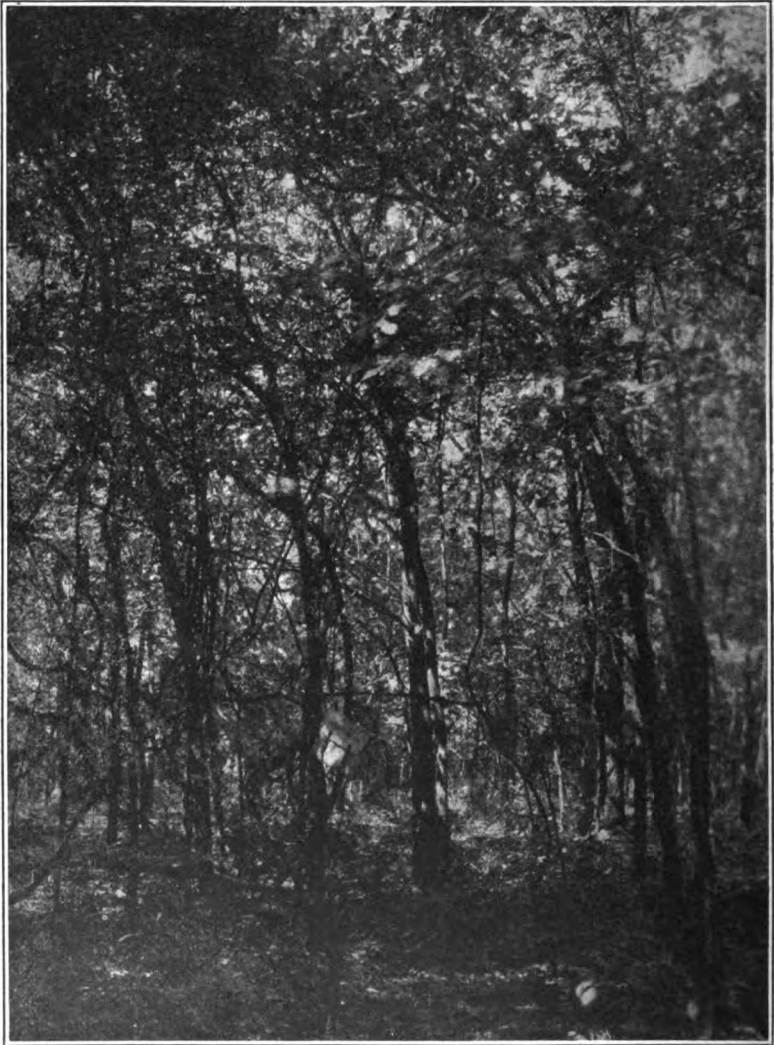


FIG. 2.—Illustrating damage done by grapevines in bending over and finally killing thrifty young trees. Vines should be cut out.

the trees. Old trees show the abuse in the dying of their tops, in a decrease in the amount of foliage, and often through the beginning of decay at the butts. A light cover of grass then makes its appearance and increases the drying out of the soil.

When the crown canopy of a wood lot is unbroken, and young growth is not desired, a few head of cattle are permissible. They

should not, however, be turned in when the ground is very soft—when the frost is going out, for instance, or during a rainy season. The



FIG. 3.—Wood lot in which cattle and hogs have run. No reproduction; roots exposed; results in little growth and a decrease in value of material.

soil is too easily compacted at that time. When it is desired to secure natural reproduction, hogs may be turned into the wood lot shortly



FIG. 4.—A well-managed second-growth wood lot in Indiana, not grazed. Maximum production of wood.

before the seed is to fall. They will root up the ground and thus put it in good condition for the reception of the seed.

Goats and sheep should be allowed in the wood lot only when it is desired to clear up brush of undesirable species, so as to make possible the reproduction of better ones. If the better species are already present in mixture with the poorer ones, some method of cutting, rather than grazing, should be followed to clear the area of the poorer species. Horses should at no time be permitted in the wood lot.

Stockmen are quite generally agreed that grass produced under the shade of timber is considerably less nutritious than the same species growing in full sunlight. It is also usually much more sparse. The actual value, then, of woodland pasture is small. One dollar per acre per year is probably a liberal estimate of the value of the forage. Thrifty fully stocked stands of timber will grow at the rate of 250 or more board feet of lumber per year. Adopting only 250 board feet as the growth and assuming the value of the standing timber to be from \$5 to \$8 per 1,000 feet board measure, the value of the timber growth is from \$1.25 to \$2 per acre per year. Stumpage values are sometimes much higher than this, especially if there is considerable white oak, tulip poplar, walnut, or other valuable species in the stand. If the timber is given good care, moreover, the growth should be as much as 500 board feet per acre per year. The larger value of the wood lot for growing timber, as compared to the value of its forage only, is apparent.

It must not be thought possible to secure this growth of timber and utilize the wood lot for pasture at the same time. Grass in the wood lot is almost an infallible indication that the wood lot is not fully stocked or is being mistreated. Grass will not thrive without strong sunlight, and in a wood lot in good condition sunlight reaches the forest floor only to a very limited extent. Pasturing and timber production can not, therefore, be practiced on the same area except to the mutual disadvantage of each; and the combination of the two will not be as remunerative to the owner as the practice of either one separately. It must be admitted, however, that the value of the shade to stock may more than offset the loss in timber growth sustained through the practice of pasturing. Just what this value is, foresters can not say; but to the farmer who pastures his wood lot and to those interested in timber production as a farm crop, studies looking to the solution of this question would be very helpful in formulating plans for the future. If shade, however, rather than forage is the wood lot's chief value to stock, it can doubtless be provided by allowing the stock to range in only a portion of the lot. The remainder can more profitably be devoted to the production of wood alone.

FIRE PROTECTION.

Because wood lots exist for the most part as small scattered bodies of timber which are constantly under the owner's supervision, there need be very little damage from fires. Owners are doubtless in some instances indifferent about fires in their wood lots because they do

not realize that these may do great damage without giving striking evidence of the fact. They burn the fallen leaves and accumulated litter of several years, thus destroying the material with which trees enrich their own soil. The soil becomes exposed, evaporation is greater, and more of the rain and melted snow runs off the surface. The roots may also be exposed and burned. Conditions are such that the vitality of the trees is weakened and their rate of growth decreased. Fires usually destroy the greater part of the young seedlings up to one inch in diameter. This young stuff is commonly called "brush," but it must be remembered that every large tree was in the "brush" stage once and that the "brush" of to-day will be the large timber trees of the future. Very severe fires destroy some of the larger trees and burn through the bark of others. These wounds lower the value of the butt log for lumbering purposes, and they afford a ready point of entrance for rot-producing fungi, which may cause deterioration in the quality of the logs for a considerable distance above the wounds. By the entrance of rot the sale value of a tree may easily be decreased by from one-half to two-thirds. Rotten logs are seldom classed as No. 1, and usually as culls. Fires, then, may be expected to destroy the vegetable manure of the forest floor, to kill young growth, to weaken vitality and growth of older trees, and to lower the sale value of timber. Through the killing by fire of the young growth, which permits more light to reach the forest floor, the growth of grass is encouraged and pasturing is probably made somewhat better, but the burning of woods to better the pasture is indefensible.

INSECTS AND FUNGI.

Damage from either insects or fungi is always possible. It is more likely to be serious with some species than with others; and fungous attacks are much more likely to be serious in woods which have been damaged by fire, grazing, lumbering, wind, or any other agency which has served to break the bark or roots and expose the living inner tissues. The damage done by a leaf-eating insect is apparent in the destruction of the foliage. When the insect is one that works under the bark and either bores into or girdles the tree, its presence is manifested by fine sawdust-like particles of wood which fall out of the burrows and collect either around the base of the tree or at the entrance of the burrows. Sap or gum also often exudes from these entrances. When the attack is serious, the leaves of hardwoods change to their autumnal color, while those of conifers become brown or red. The bark of trees killed by girdling insects becomes loose; and on its inner surface, as well as on the surface of the wood of the tree, there will be found more or less numerous regular wavy passages, or so-called galleries. These are formed by the grubs as they eat their way under the bark. The wood is their food during the course of their development.

The presence of wood-rotting fungi is indicated by hollow stems, discoloration, and rot of the wood, and by the fruiting bodies of the fungus. These are the mushroom or bracket-shaped bodies which appear somewhere on the trunk, branches, or roots of the tree, most often at some point where the tree has been wounded. Other types of fungi which may seriously damage trees but do not rot the wood may have rather inconspicuous fruiting bodies, but are manifested by an unhealthy appearance of the tree, dying of the branches, distorted twigs or branches, sunken places in the bark, and possibly other indications.

Full information in regard to the damage from either of these sources and the methods of control can usually be secured either from State experiment stations or the United States Department of Agriculture, Washington, D. C.

CARE IN LOGGING.

When the timber on the wood lot is being cut steps can be taken to insure the perpetuation of the wood lot and at the same time improve the quality of the stand. Lumbering operations which remove only trees of high quality, such as white oak or black walnut, and leave dead, dying, insect or fungous attacked specimens, and inferior trees, such as beech, should not be practiced. The beech, ironwood, dogwood, and other inferior species which remain will scatter their seed over the ground, and the future stand will be made up very largely of these. The diseased and dying trees will be a menace to the remaining healthy ones. In cutting, therefore, or in selling the standing timber, provision should be made that these inferior species be taken down to a smaller diameter than the more valuable ones and *all* defective trees be removed. To make such a provision effective, the owner should mark in some manner all the trees which he desires cut or all those which he wishes to retain in his wood lot. To induce the lumberman to take inferior species and small and defective trees, it may be necessary to make some concessions in regard to price. The trees which remain will be the nucleus of the future crop, and valuable species should be in the majority in sufficient quantities to seed up the cut-over areas.

Unless small trees bring higher prices per unit of measure than large ones, or unless they are of species which it is desirable to eliminate, they should not be cut by the wood-lot owner, nor should he allow lumbermen to cut them. Trees 10 inches and less in diameter cut only very small amounts of low-grade lumber; so that their value is very small. Ordinarily, if they are to be sawed into lumber, the lumberman figures on paying little or nothing for them. He can not afford to do otherwise. Trees of such sizes, however, are usually growing rapidly or will do so when the other trees are removed and they receive more sunlight. As they increase in size, they will cut

not only more but higher grade lumber; and they will, accordingly, increase in value in a greater ratio than in size. It is apparent that they should not be cut.

In felling trees, care should be taken not to throw them into the midst of a group of young trees, otherwise these may be seriously broken or bent. Further, by the exercise of a little care when dragging the logs out of the woods, much breakage, bending, and trampling of the young growth, or "brush," can be avoided. It must be kept in mind at all times that this "brush" is the first stage in growth of the mature timber. Every care should be taken to prevent its destruction, particularly in the better species, because it represents an established growth several years in age. A new stand of seedlings may not only be difficult to obtain, but will not have the advantage of this several years of growth. When standing timber is sold, the lumberman should be charged with protecting this young material as fully as possible.

When cutting for his own use, the owner should, so far as possible, observe rules similar to those outlined for lumbering operations. Dead and defective trees can be used for cordwood; the poorer species may sometimes serve nearly as well as the better ones for a special farm need; damage to young growth can be avoided; and the operations can be carried on at such a season of the year and in such a manner as will aid effective sprout reproduction.

METHODS OF REGENERATION.

A very striking condition in by far the greater proportion of wood lots is the absence of small trees. In those few wood lots which are fully stocked with even-aged trees of relatively even sizes, smaller trees need not be expected nor should their growth be encouraged. Where, however, as is much more commonly the case, the wood lot is made up partly of mature and partly of decadent trees which should be cut and whose crowns do not fully shade the ground, there should be young trees coming up in the openings. Under normal conditions, these young trees would be present, but because of pasturing and fires they do not start. Grass appears instead; and, if pasturing and fires continue, conditions become such that, without aid, there is little possibility of securing a natural growth of young trees.

RESTOCKING BY SEED.

If the wood lot has not been too badly abused and there is not a heavy sod of grass present, the exclusion of stock and fires will normally result in its restocking itself in time by natural seeding. Good seed years, however, occur only at intervals. Even with a good seed year, the seedlings may not be able to get a start because of the sod, the packed condition of the soil, or unfavorable weather. Natural reproduction may, therefore, be very slow, becoming satis-

factory in amount only after from 10 to 20 years. It will often be advisable, therefore, when there is a good crop of seed on the trees, to put the ground in such shape as to insure a good crop of seedlings. Before the seed is scattered from the trees in the autumn, the ground can be disk harrowed or cultivated, or hogs can be turned in to root up the soil. The seed will then lodge in the soft earth, where, upon sprouting, the roots may easily take hold. To prevent undesirable species from obtaining a foothold, any trees of such species large enough to bear seed should be cut at the time that pasturing is discontinued.

REGENERATION BY SPROUTS.

It is not always possible to secure a new growth through sprouts from the stumps of felled trees. Most conifers do not sprout effectively, and the majority of hardwoods do not sprout vigorously beyond the age of 60 years. Basswood and chestnut are exceptions, for they can be depended on to sprout well from healthy stumps up to an age of 100 years. Individual vigorous trees of other species may also often do likewise. Sprout regeneration, then, is especially applicable to hardwood stands which are to be cut when young, as, for instance, stands which are to be cut over every 20 to 30 years for posts or fuel. It should be remembered that sprouting is most vigorous from low stumps. It is also better from the stumps of trees cut during the winter or very early spring. Such sprouts, moreover, are less liable to severe winter injury at the end of their first season's growth than are those arising after timber is felled during the summer.

In felling the trees, care should be taken to injure the stumps no more than can be helped, because the best sprouts will ordinarily arise from good, clean stumps. Because of the clean cut which it makes, the axe is a better tool than the saw in felling trees where regeneration by sprouts is desired. Regardless of what tool is used, the surface of the stumps should be slanting, so that water will not collect and promote rot.

PLANTING OR ARTIFICIAL SOWING.

Some wood lots are so run down that very little seed is produced and natural reproduction can not be secured even if the area is disked or harrowed, or at least can not be secured rapidly enough to be satisfactory. Often it is desirable to grow different species than those present or to grow a greater proportion of one species than another. Sometimes no wood lot exists at all, but one is desired. In these cases artificial sowing or planting is necessary.

Where it is desired to establish a wood lot by sowing or planting, the areas to be selected for the purpose merits some attention. A large percentage of the farmers in the unwooded plains region have planted wood lots around their buildings and feed lots, primarily

for protective purposes. Although the trees were usually planted on very good agricultural soils, these men considered that tree production was justified even though the wood produced was not equal in value to the agricultural crops which could be grown on the same land. The monetary value of the protection to live stock and the saving which it has meant in winter fuel is difficult to estimate. Determinations have been made, however, in regard to the effect of trees as windbreaks upon the wind velocity and upon crops protected by them from the prevailing summer winds. It has been found in the prairie region that through the protection afforded by the most efficient grove windbreaks, the yield in farm crops is increased to the extent of the crop that could be grown on a strip three times as wide as the height of the trees.¹



FIG. 5.—Knolls on which timber may possibly be the most profitable crop.

Where protection is not considered essential, the logical places for establishing a wood lot are on those portions of the farm which are so steep or which have a soil so rocky, sandy, or wet that the returns from agricultural crops are very meager. (See figs. 5 and 6.) Steep hillsides in particular are liable to erosion; and even though good returns can be secured for a few years from growing agricultural crops on them, they are likely eventually to become so eroded as to be practically useless for such purposes. Such lands can in the long run be more profitably devoted to the growing of timber. Low lands which are not satisfactory for the growing of farm crops will produce excellent stands of some species of timber within their natural range, such as cottonwood, red gum, elm, swamp white oak, and others of a moisture-loving kind.

¹ Forest Service Bulletin 86, "Windbreaks," 1911.

Species.—The species of trees to be given preference in planting or sowing operations should be those which are native to the region and which are of the most rapid growth. These are shown in Table 2. Though some of these most rapid growing trees are not at present so valuable commercially as the more slowly growing ones, their values are increasing and their future increase will probably be proportionately greater than that of the others.

Spacings.—The proper spacing to give in planting trees depends largely on the habit of the species and the character of the site. In general, the more tolerant the trees are of shade and the more unfavorable the site, the closer should be the spacing. Very close spacing reduces the number and the size of the branches, which means that the trees will be of higher lumber value. It means,



FIG. 6.—Type of land which should be planted to forest trees.

however, a greater death rate among them due to competition, and a higher initial cost of planting because of the greater number of trees required per given area.

On the unfavorable sites, close spacing is best. The same is true even on the better sites when cultivation can not be practiced for the first two or three years. The greater number of trees per acre offsets the higher mortality when first set out, and it results in better protection of the soil through the greater amount of shade furnished.

Species which are tolerant, or in other words will grow well under shade, such as hard maple, beech, spruce, and hickory, can be spaced more thickly than those which are not tolerant, such as cottonwood, red pine, and black walnut. The best results will ordinarily be secured by sowing or planting a mixture of species, such as the cottonwood and soft maple, the black walnut and hickory or white oak, or the

yellow poplar and hard maple. In these cases the cottonwood, black walnut, and yellow poplar would be spaced 8 to 12 feet apart and the soft maple, hickory or white oak, and hard maple would be planted midway between them. Such a combination induces rapid height growth of the first-named kinds of trees, and causes them to shed their lower branches early in life, but because of the ability of the maple, hickory, and oak to live under the shade of the cottonwood, walnut, and poplar, the ground is kept well shaded and in good condition. It being kept in mind that where wide spacings are followed, it is desirable to fill in between with more slowly growing but tolerant trees; spacings about as indicated in Table 4 should be given when the trees are to be grown to an age of 40 years or more. It is not intended to thin the stand at an earlier age.

TABLE 4.—*Spacing to be followed in forest plantation.*

Spacing in feet.					
12 by 12	8 by 8	7 by 7	6 by 6	5 by 5	4 by 5
Number of trees required per acre.					
303	680	889	1,210	1,743	2,178
Cotton-wood.	Yellow poplar. Red gum. Loblolly pine.	Short leaf pine. Chestnut. Black locust. Bald cypress.	White pine. Red pine. Red oak. Black oak. Black walnut. White ash.	Hickory. White oak. Chestnut oak. Burr oak. Post oak. Red elm. Basswood.	Hard maple. Yellow birch. Beech. White spruce. Red spruce. Fir.

The species in the last two columns will withstand considerable shade without being killed, and are the ones accordingly which can most safely be used in planting midway between such trees as are shown in the first three columns.

If seed are to be sown rather than trees planted, the quantity to be used per acre depends upon a number of considerations, such as the quality of the seed, the amount of preparation given the soil, the danger of the seed's destruction by squirrels, mice, birds, etc., its price, the rate of growth of the seedlings, and their sensitiveness to frost, drought, and other such damage. If the seed is scattered broadcast on soil prepared by plowing and harrowing like grain, some such amounts as follow will be required per acre:

White and chestnut oaks.	12	Fir	45
Red and black oaks.	8	Spruce	6
Ash	40	White pine	8
Beech	130	Red pine	5
Maple	40	Chestnut	8
Elm	24	Hickory	8
Birch	32		

If the seed are to be placed in prepared spots evenly spaced over the area, two or three such seed as walnuts, hickory nuts, or acorns should be placed in each spot and about ten of any of the other species. This is simply to guard against failure due to the seed not sprouting, its destruction by rodents, or the death of some of the seedlings after sprouting has occurred. The total quantity required per acre will be about one-fourth to one-third that necessary in broadcast sowing.

Stock.—In general there is more certainty of success from planting trees grown in a nursery than from sowing seed directly on the permanent site. The nut-bearing trees, however—walnut, oaks, and hickories—develop during their first year a deep taproot with very few laterals. This rather unfits them for growing in a nursery and later removing them to the field. The most practicable method with these species is to sow the nuts directly in cultivated spots in the field. Fall sowing is usually preferable to spring sowing unless there is danger of the nuts being disturbed by rodents.

One-year-old hardwood seedlings and two or three year old nursery-grown coniferous seedlings or transplants are the best classes of stock for planting. They are not so large as to be unduly expensive, and ordinarily small stock is more likely to succeed than large. Transplant stock of coniferous species usually has a better root and is sturdier than seedling stock. It is accordingly more suited for planting on inhospitable sites and for all sites where no cultivation can be given following planting.

Hardwood seedlings can very easily be grown for planting. The seed can be collected locally or bought. It should be sown in prepared beds in much the same manner as a vegetable crop and the young trees will require no more attention than such a crop. Coniferous seedlings or transplants require more attention for their successful production and it will usually be best to purchase such stock from a reputable nurseryman or from the State nursery, if one is maintained by the State. At present the following States maintain their own nurseries and distribute trees either free or practically at cost to planters within the State: Maine, New Hampshire, Vermont, New York, Maryland, Pennsylvania, Ohio, Michigan, North Dakota, and Kansas.

If purchased from nurserymen, the cost of hardwood stock will range from \$2 to \$10 per thousand trees, and that of conifers from \$3 to \$12. The nurseries which handle stock of certain trees and their quoted price on the same can be secured from the Forest Service, Washington, D. C., for all the more important species.

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UNITED STATES DEPARTMENT OF AGRICULTURE



FARMERS' BULLETIN



WASHINGTON, D. C.

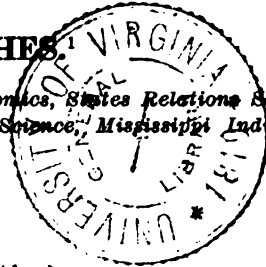
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MARCH 17, 1916

Contribution from the States Relations Service, A. C. True, Director.

SCHOOL LUNCHESES

By CAROLINE L. HUNT, Assistant in Home Economics, States Relations Service, and MABEL WARD, Late Director of Home Science, Mississippi Industrial Institute and College.



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INTRODUCTION.

What should school children be given to eat at noon? What foods are best for the school lunch basket? The frequent asking of these questions shows that mothers and others interested in children's welfare have unusual difficulty in planning this meal. There are no special scientific principles which apply to it more than to the other meals, for, of course, choosing healthful foods and preparing them carefully are no more necessary at this than at either of the other meals of the child's day. Nor is it wise always to study one meal apart from the other two. The three taken together must, if they are to satisfy the needs of the growing body, supply several different kinds of food materials. It is seldom convenient to provide all of

¹ Prepared under the direction of C. F. Langworthy, Chief, Office of Home Economics.

NOTE.—This bulletin is of special interest to housekeepers throughout the country, particularly those with children of school age.

these at one meal, and those which are left out of one meal must be supplied at another. Breakfast, dinner or lunch, and supper should, therefore, usually be thought of together as necessary to the making of a complete day's ration.

On the other hand, it is particularly difficult to live up to one's ideals in a meal which is almost always hurried and which must often be prepared in one place and served in another. The mid-day meal of school children on days when school is in session has, therefore, problems of its own and may well be occasionally discussed, as it is in this bulletin, apart from all other meals.

There are some places, small towns, for example, where dwelling houses and schools are so close together that pupils can easily go home at noon. In these cases the thought or care necessary for the noonday meal is along the same lines as that given to breakfast and supper. There are other places, however, and these include large cities as well as rural districts, where children are obliged, because of distance, to remain at school over the noon hour. Under these circumstances most children carry their lunches. Some, however, particularly in cities, are given money with which to buy food. This practice is, of course, open to dangers, for the money is too often spent in shops or at pushcarts over which those who are most interested in the children's welfare have little control. To insure that food is prepared under proper conditions, lunch counters or lunch rooms have been established in many school buildings, where pupils may buy full lunches or certain dishes with which to supplement food brought from home. There are schools, too, where the task of preparing lunches, or at least one or two of the dishes to be served at noon, is given to cooking classes as a laboratory or practice exercise.

Any discussion of lunches for school children must, therefore, take into account (1) the children who go home at midday, (2) those who carry their lunches, (3) those who buy them at shops or at the school, (4) those who are supplied by the school through the cooking classes, and (5) those who carry part of each day's lunch and depend on being able to buy something at or near the school to add to what they carry.

FOODS FOR CHILDREN.

The essentials of the diet of all normal children are, of course, the same—namely, an abundance of simple foods carefully prepared and of sufficient variety to provide for activity, which in healthy children is almost ceaseless during waking hours, and for development into healthy manhood and womanhood. For this reason the general subject of food for children will be discussed before the special problems of the school lunch.

THE PLACE OF BREAD IN THE DIET.

One of the chief practical food problems, whether children or grown people are concerned, is how to get good, wholesome, clean bread. It has been shown that cereals provide nearly one-third by weight of all the food eaten by the American people¹ and that they supply nearly half of the protein (commonly referred to as tissue-building material) and nearly two-thirds of the fuel or energy. The greater part of these cereals is, of course, served in the form of bread of one kind or another. The quality of the bread which is eaten is, therefore, an extremely important consideration.

It is not possible within the limits of this bulletin to give directions for making bread, nor is it necessary, for recipes can be obtained from any good general cookbook. All that can be done here is to speak of the qualities of good bread. These are perhaps most clearly and concisely stated in the score cards commonly used in bread-judging contests at State fairs, farmers' institutes, and elsewhere. Such cards are designed especially for judging loaves of wheat bread, but with a little modification they can be used also for breads made wholly or partly of other cereals (corn, rye, oatmeal, etc.) and for bread in other forms, such as biscuits and rolls. In all cases the characteristics of the crust and the crumb (the inside of the loaf), the lightness, and the flavor are taken into consideration.²

The crust should be crisp and deep (indicating thorough baking), but not hard or burned. The crumb should be elastic; that is, it should be capable of being compressed by slight pressure, but should spring back to its original form when such pressure is removed. If the dough is made too stiff, the crumb can not easily be compressed, and if too thin or if insufficiently baked, the crumb is soggy and inelastic. A crumb which is neither too hard nor too soft can easily be broken up in the mouth during the process of chewing and will neither form a sticky mass nor be too dry to taste good.

Lightness is an important feature of quality. It depends on the size of the loaf as compared with its weight, a point which experienced bread makers can usually judge by lifting a loaf and by noting if the shape is symmetrical and the crust unbroken. When the loaf is cut the air cells should be found evenly distributed, of about the same size throughout, and nearly round in shape. Cells which are higher than they are wide show that the bread has risen too much and is likely to be dry or sour. There should, of course, be no close, heavy streaks. In making bread the best results are obtained by letting the loaves double their volume in the pan and by

¹ U. S. Dept. Agr., Office Expt. Stas. Circ. 110 (1912). Food Customs and Diet in American Homes.

² Univ. Ill. Bul. 10 (1913), No. 25.

beginning the baking at such temperature that the rising will continue about 10 minutes in the oven.

The flavor of bread, which is determined by taste and odor, is difficult to define, except by saying what it should not involve—sourness and rancidity. The flavor of wheat bread is often described as that of the original wheat as it is obtained by chewing the grains. In like manner, the flavor of other breads should suggest that the original materials were in good condition at the beginning and that they have not undergone any undesirable changes during the process of bread making.

All of these qualities—lightness, good flavor, a crisp and deep crust, and an elastic crumb—can be secured in rolls and biscuits as well as in large loaves. The objection to hot bread is not due to the fact that it is hot (if it were, hot toast would be indigestible, i. e., cause distress), but that it lacks some of the characteristics mentioned above. Large or thick biscuits, whether raised with yeast, baking powder, or soda, are likely, if cooked only a short time, to be soggy on the inside, and this, when it happens, is the objection to them, rather than the fact that they are served hot.

If the diet is limited in kind and quantity, bread made from the so-called whole-grain flours is especially useful; if it is varied and abundant, other foods can supply the nutritive material which characterizes the branny layer of the grain.

The use of different kinds of bread is to be recommended in general, for variety in the diet is pleasing, and this is an easy way to secure it. Sometimes so simple a change as baking the bread in a new form, a twist, for example, instead of a loaf, or cutting bread and butter in a fancy shape with a cooky cutter, will increase a child's relish for it. So, too, will a change of flavor, obtained by adding a few raisins, dried currants, or nut meats.

Cereal mushes and ready-to-eat cereal breakfast foods supply much the same nutrients as bread. In a very general way a half cupful of cooked cereal mush or one cupful of puffed, flaked, or shredded cereal is equal in food value to a good-sized slice of bread (1 ounce).

The above allowance of any one of these cereals with one tablespoon of cream is about equivalent to the slice of bread mentioned (1 ounce) spread with about one-sixth of its weight of butter, a moderate and not unusual allowance. Cereals with cream resemble bread and butter in their nutritive value more closely than cereals (with milk do (see p. 5).

Probably one reason why bread and cereals in other forms make up so large a part of the food of people is because they come near in themselves to fulfilling one of the important requirements of the diet—a right proportion between the nutrients which provide fuel

only and those which can be used for body building. Or, expressing these in terms of the needs of the child, they come near to providing for activity and also for growth. To come near to doing a thing, however, is not to do it, and with bread and butter should be served, as a rule, some of those foods which provide protein in larger proportion as compared with fuel. These foods include milk, meat, fish, poultry, eggs, cheese, dried beans, cowpeas, peas, peanuts and almonds, walnuts, and other nuts.

Among these protein-rich foods, as they are often called, healthy grown people may choose at will and according to their likes or dislikes, but in the case of children no one of them is thought wholly to take the place of milk.

MILK AND WAYS OF USING IT.

The value of milk in the diet of the young is due not only to the fact that it contains a large number of nourishing substances in forms in which they can easily be assimilated, but also to the fact that in some way not now fully understood it seems to promote growth and to help the body of the child to make good use of other foods.

While milk should, if possible, have a place in the diet of all growing children, it is not necessary to serve it at every meal, and the lunch can, if this seems desirable, be made an exception. In practice, however, it has been found that such dishes as milk toast, milk soups, and cocoa are often convenient for the lunch at home, while at school they can be prepared more easily than most dishes, because they do not call for an oven or for any but the simplest cooking utensils.

Milk soups, of which there is a great variety, all prepared in about the same way, are important, not only because they can be made a means of serving milk in large quantities but also because they offer a good way to use vegetables, the value of which as food is referred to later in this bulletin. Materials other than vegetables—small amounts of fish or cheese, for example—can also be used for flavoring. These, however, tend to increase the protein rather than to add the nutrients which give vegetables their special usefulness in the diet, a fact which should be kept in mind when bills of fare are being made.

It is unfortunate for those who have charge of the food of children to be tied down to any fixed recipes for milk soups, for if so they are likely to fail to utilize materials at hand, such as those that grow in the home or school garden or those that have been left over from previous meals and are still in good condition. General directions for preparation and also a few typical recipes will be found on pages 19-21.

Other easily prepared dishes that may be the means of introducing milk into the diet are simple chowders, such as potato or corn chowder, and custards. The breakfast cereals—a large and varied class of foods, valuable in themselves—may be the means of encouraging children to take much milk. All can be served with milk; and the food value of the uncooked varieties can be further increased by using milk instead of water in preparing them. In this way skim milk, which has a higher food value than most people realize and which is too often wasted, can be made to count as nourishment.

OTHER PROTEIN FOODS.

Other protein-rich foods should be used as well as milk in the diet of all children who have passed babyhood. Eggs are usually the first of these foods given in addition to milk. They contain much iron, an ingredient in which milk (though rich in other kinds of mineral matter, particularly lime) is lacking. Gradually as the child develops, chicken, fish, meat, cheese, dried beans, peas, cowpeas, and other protein-rich foods, may be added. No great quantity is needed, inasmuch as bread and milk come near to supplying all the child's needs. These foods should not be overlooked, however, and in order to prevent this they should be thought of as forming a separate and important group of food materials which are to be drawn upon more and more as the child grows. Ways of introducing them into the diet, particularly into the school lunch, are given later.

THE IMPORTANCE OF GREEN VEGETABLES AND FRUITS IN THE CHILD'S DIET.

Vegetables and fruits are now considered a necessary part of the diet of the child. The reasons are many, but most of them may be summed up by saying that they furnish material needed to form bone and tissue and to regulate body processes. The mild acids which some of them contain help to prevent constipation; so, too, does the cellulose or fiber, especially when it is raw, though its value for this purpose may have been exaggerated in popular literature. Green vegetables are also a valuable means of introducing into the diet mineral matters, particularly iron, in a form in which the body can utilize them. Even at city prices green vegetables have been shown to be an economical source of iron. Like the protein-rich foods, therefore, they should be looked upon as a separate and important group of foods to be drawn upon regularly.

The uses of fruits in the diet are much the same as those of green vegetables, though, unlike most vegetables, they have a considerable percentage of sugar, especially when they are dried, and sugar is a

quickly absorbed fuel food. Like vegetables, they have value because they contribute some of the nitrogen required for tissue building and repair, and some energy. However, they are valuable chiefly because they supply growth-stimulating and body-regulating substances and also mineral matter needed for bone and for many other purposes. The quantity of these materials in fruits and vegetables is small, it is true, but large in comparison with the amount in many other common foods.

Fresh vegetables and fruits must be prepared with care, for there is danger of transmission of disease by means of foods that are served raw. Most people will agree that apples, pears, etc., as picked from the tree in an orchard far enough from the road to escape dust, are clean. If they drop to the ground upon clean grass they may still be eaten without much risk, although there would then be more chance for dirt, with its attendant disease-producing bacteria.

All fresh fruits and vegetables which come from the market should be thoroughly washed in several waters. Most fruits may be safely dipped in boiling water and many can be kept there for several seconds without injuring their flavor. This kills many, if not all, of the bacteria and other organisms that are likely to cling to the fruit. A convenient way to do this is to place the fruit in a wire frying basket. Grapes, apples, pears, peaches, and plums are not injured by this treatment, and unripe strawberries are often improved by it. Large fruits, such as bananas, apples, oranges, and others with unbroken skins may be safely washed with soap.

Dried fruits should be particularly well washed. If they are then put into a warm oven to dry they are likely to absorb the water which clings to them and thus to be softened and improved in taste.

DESSERTS AND THEIR SELECTION.

The dessert for any meal usually consists of fruit, either raw or cooked, of sweets, or of pastry. Most children like fruits, raw, cooked, or dried, and so they are very useful for dessert for them. Even here, however, variety should be considered, and the less common uses for fruits are worth noting. For example, in a certain boarding school the children are given daily a food resembling candy, which is made of finely chopped dried fruits and nuts mixed together, rolled out, and cut into squares like caramels. These are very palatable and nutritious and are believed to prevent constipation. (See recipe for Fruit and Nut Confection, on p. 24.)

Pies and other kinds of pastry add much fat to the diet, the amount of fat in many kinds of pie (taking crust and filling together) being more in proportion to weight than in any meat but the very fattest. Most authorities on food believe that it is better

to serve fat to children in the form of butter, milk, cream, egg yolks, or uncooked salad oils than in the form of rich pastry or rich sweets—i. e., desserts that are heavily sweetened and also very fat.

Experience has shown that fruits, fresh or served in simpler forms (baked, stewed, or raw), and simple sweets are better forms of dessert for children than preserves or rich pastry. Sweets may be given in the form of cake (not too rich or it comes in the class of pastry), cookies, sweet sandwiches, simple candy, honey, dried or preserved fruits, maple sugar, and loaf sugar, and in many other ways. Highly flavored and spiced foods should be avoided because they spoil the appetite for simple flavors.

FOODS CONVENIENTLY GROUPED.

Going back over what has been said about the kinds of foods desirable, the subject may be summed up by saying that the important elements of a child's diet are milk, supplemented at times by other protein-rich foods but never wholly omitted; bread or cereal food in other forms; butter or other foods containing much fat; vegetables and fruits; and sweets. In general, it may be said that the school lunch, like the diet as a whole, should contain representatives of the following groups:

Groups 1. The protein-rich foods.—Milk; cheese; meats (except the very fattest); fish; poultry; dried beans, peas, and cowpeas; peanuts; and others. The reasons for including peanuts are their high percentage of protein and the fact that in finely divided form they are used as sandwich filling. Other nuts are rich in protein but are at present seldom used in the child's diet in sufficient quantities to make it necessary to enumerate them here.

Group 2. The cereal or starchy foods.—Breads, cereal mushes, ready-to-eat cereal breakfast foods, rice, macaroni, tapioca, and others.

Group 3. The fatty foods.—Butter, cream, salad oils, bacon, and others.

Group 4. Vegetables and fruits.—Here some confusion may arise because the term "vegetable" is sometimes used to mean all foods of plant origin and in this sense would include cereal, dried beans, and other foods which have been classified elsewhere. As here used it applies only to those which are used as side dishes with meat or as salads and in similar ways—potatoes, greens, lettuce, celery, green peas and beans, carrots, asparagus, and others. Under this heading come also all cooked or raw fruits, with the exception of those to which much sugar has been added (preserved or candied fruits, marmalades, and others) and dried fruits in which the percentage of sugar is high because most of the water has been driven off. Such sweet fruits are more properly classed under group 5.

Group 5. Simple sweets.—Cakes and cookies which contain little fat; cane sugar; plain candies; maple sugar; sweet chocolate; jellies; preserved fruits; jams; marmalades; honey, molasses, and other sirups; dried figs, dates, raisins, and other dried fruits and similar foods are members of this group.

If, as a general rule, each of the above groups is represented, the diet is likely to contain all the important nutrients—protein, fat, starch, sugar, mineral matters, and growth-stimulating substances—in reasonably correct proportions, and to have an energy value sufficient for the child's needs. If all groups are represented no one kind of foods is likely to be used in excess.

The food materials which are regularly used in the household are so many and so varied that they can not, of course, be perfectly classified under a few heads. It would be difficult, for example, to say where dried beans belong, for they have much protein and also much starch. Mutton would naturally come under the protein-rich and also under the fat foods. In spite of such difficulties, there are many advantages about such a grouping system as that mentioned above. One is, that it leads the mother or housekeeper to think of the special value of each of the groups and prevents her from omitting representatives of any of them from her bills of fare for any long period. It is likely to prevent her, for example, from making up a lunch which consists only of starchy foods and sweets (bread-stuffs and cake), as so many lunches now do.

It should prevent her also from serving meat and eggs, or meat, eggs, and milk at the same meal, with no fresh vegetable or fruit. Again, it prevents the omission of members of one group without some very good reason. In general, economy is most likely to be necessary in the protein-rich foods and in the fruits and vegetables, for these are usually high priced. Among the first mentioned are such foods as dried beans, peas, cowpeas, peanuts, walnuts, and pecans, as well as eggs, milk, cheese, and flesh foods; and often, though by no means in all cases, the vegetable foods in the group are cheaper. To learn, therefore, to prepare attractively the lower-priced members of the group is far better than to omit the group entirely in order to save money. The same may be said of fruits and vegetables, which could be raised in the home garden more often than they are, or gathered in the woods by children as a school exercise.

A meal in which all of the important kinds of food are represented tends to keep the child in good condition and to give him good habits of eating. The liking for a large range of foods is desirable from the standpoint of diet and also of manners, for it helps to prevent a person from becoming a disagreeable table companion—one who is

"fussy" about his food. Meals that are carefully planned help also to give the child some little idea of what those who know most about foods have in mind when they speak of a possible "balanced"—or better, a "rightly chosen"—ration. With children it is far more important to suggest the value of such a ration by the character of the meals given to them than to try to tell them what it is or to what extent it has been worked out.

THE NOON MEAL AT HOME.

There is no reason why the ordinary family dinner should not be suitable for school children or served in a way that adapts it to their needs. The usual first course of meat and vegetables contains nothing, except the meat, which can not be given even to the youngest children. The vegetables, providing they are carefully prepared by simple methods, are specially needed and can often be made attractive to children by being served with a little meat gravy. As a substitute for the meat itself, milk can be provided in the case of the younger children. These articles, with the bread and butter, provide most of the food needed.

The dessert course is suitable for children as well as for grown people unless it consists of rich pastries or puddings. The latter are not considered wholesome for children, if for no other reason than that they are likely to lead to overeating. Such desserts as fruit, fresh or cooked, with cake; cereals with milk or cream, and sugar; custards and custard puddings; gelatin dishes; simple ice cream; water ices; and other simple desserts may be given.

Whether or not the family meal is healthful for children depends not only on the food materials selected, but also on the way in which they are cooked. Simple methods are to be preferred from the standpoint of health as well as from that of the housekeeper's time. All dishes that are likely to contain overheated and scorched fats, such as foods carelessly fried in a pan in a small amount of fat, should be avoided. Deep-fat frying is open to fewer objections since, if properly done, foods will absorb little fat and the fat will not scorch. Vegetables cooked in water or in their own juices and seasoned with salt and a little butter or cream, are easier to prepare than those that are served with white sauce, scalloped, or cooked in other elaborate ways.

What is said above applies equally to all meals. There is, however, one special precaution that applies to the noon meal when it is hurried. This refers to tough, hard foods that are likely to escape proper mastication. It is a mistake to think that the foods given to children must always be soft or finely divided, for children's teeth need exercise quite as much as their muscles do. When time for eat-

ing is limited, however, it is well to omit foods that are difficult to chew, and in extreme cases it may be necessary to serve only soft or finely divided foods—sandwiches made from crustless bread with finely chopped fillings, for example. Before resorting to this, however, it is well to make sure that the time for eating and for insistence on good table manners is not unnecessarily cut short. The advantage of putting the meal on the table promptly and of having foods served in individual portions, or at least ready to eat when they are brought to the table, should be kept in mind. To have the meat already sliced and the dessert in cups instead of in one large dish from which individual portions must be served, and to follow the same general plan with other foods may change a hurried meal into one at which there is plenty of time for attention to details essential to health and good manners.

If special lunches, different from those prepared for the family in general, are to be given to school children, the following are suggested as bills of fare. They are only typical and many others might be given which would be just as good.

SUGGESTED BILLS OF FARE FOR THE HOME LUNCH.

1. Eggs, boiled, coddled, poached, or scrambled; bread and butter; spinach or other greens; cake.
2. Beef stew with vegetables; milk; crisp, thin tea biscuits; honey.
3. Dried bean or pea purée; toast; baked apple; cookies.
4. Vegetable-milk soup; zwieback; rice with maple sugar and butter or with milk or cream.
5. Potato chowder; crackers; jelly sandwiches.
6. Cold meat; creamed potatoes; peas; bread and butter; frozen custard or plain ice cream and plain cake.
7. Lamb chop; baked potatoes; bread and butter; sliced mixed fruits; cookies.
8. Baked omelet with spinach, kale, or other greens; bread and butter; apple sauce; cake.
9. Milk toast; string beans; stewed fruit; cake.
10. Boiled potatoes; codfish gravy; bread and butter; lettuce; custard.

THE BASKET LUNCH.

The basket lunch is harder to plan and also to prepare than the lunch at home. To begin with, there are many foods which can not be included in it, either because they are not good cold or because they can not be conveniently packed or easily carried. This leaves fewer foods to choose from, and so extra care is necessary to prevent sameness. Extra care is needed, too, in the preparation of foods that must be packed in small compass and kept for several hours before being eaten and that must very often be carried over dusty roads.

On the other hand, the number of foods that can be easily carried has been enlarged of late by the possibility of using paraffin paper and parchment paper, in which moist foods can be wrapped so as to prevent them from sticking to other foods. Paper cups, jelly glasses, and so on, are also a help, for in them sliced raw fruits, stewed fruits, custards, cottage cheese, and other half-solid foods can be carried.

The quality of the bread used in the basket lunch is especially important because it is commonly served in the form of sandwiches and is, therefore, to be considered not only as a food in itself but also as a means of keeping other much-needed foods in good and appetizing condition, or of serving them in attractive ways.

Variety in breads, too, is more important at this than at other meals because of the danger of monotony. Wheat bread, whole-wheat bread, corn, rye, or oatmeal breads; nut, raisin, and date breads; beaten biscuit, rolls, crisp baking powder biscuit, or soda biscuit, and toast, zwieback, and crackers may be used in turn to give variety. Rolls hollowed out can be made to hold a large amount of sandwich filling, which is an advantage at times.

PACKING THE LUNCH.

Many kinds of lunch boxes, pails, and baskets are now on the market. The chief advantage of most boxes and pails is that they are made of metal and can, therefore, be easily cleaned and scalded to keep them in safe condition. Some boxes have the advantage over pails that they can be folded when empty and strapped with the school books. Baskets are ventilated and for this reason suitable for carrying moist foods which are likely to spoil. There is no reason, however, why small holes can not be punched in metal boxes or pails to let in the air. Baskets can, of course, be washed or scalded, but not so easily as metal containers, and they should be frequently cleansed. There should, in fact, be no part of any food container that can not be cleaned. For this reason the simplest boxes and baskets are often better than the more elaborate ones with compartments in which to keep dishes, knives, forks, and spoons. With the increase in automobile travel, well-constructed boxes and baskets which can be easily cleaned have come on the market with compartments for keeping food hot or cold and for holding liquids. These are, of course, suitable only for children who ride back and forth, and particularly suitable where several lunches are put up in one household.

The precautions which must be taken to keep foods clean and safe differ with circumstances. In dusty seasons they should be wrapped particularly well. In hot weather the use of soft, moist foods in which molds and bacteria are most likely to grow rapidly should be

avoided. Although chopped meat moistened with a dressing of some kind makes a good sandwich filling, such foods are less desirable in hot weather than slices of meat, peanut butter, or other foods less liable to spoil.

Paper napkins or the somewhat heavier paper towels of much the same size are very useful for packing lunches, and, like paraffin and parchment paper, may now be obtained at a low price, particularly if bought in rather large quantities. If no provision is made in the school for serving lunches, an extra napkin, either of paper or cloth, should be put in the basket, to be spread over the school desk when the lunch is eaten. Napkins can be made out of cotton crêpe at a cost of a very few cents each. The crêpe may be bought by the yard, and should be cut into squares and fringed. Such napkins have the advantage of not needing to be ironed.

In packing the lunch basket put at the bottom the things least likely to crush, and wrap the sandwiches, etc., into neat parcels, not all in one. Paper cups; jelly tumblers with covers, which can now be bought in several sizes; bottles with screw tops, such as those in which candy and some other foods are sold; and small jars such as those in which some goods are sold by druggists, can all be used for packing jellies, jams, and honey, as well as the foods mentioned above. When clean and in good condition, empty receptacles of this kind can be saved for use in the lunch basket.

A few bills of fare for basket lunches follow, which may help in deciding what is satisfactory for the purpose. Many others equally good could be suggested.

SUGGESTED BILLS OF FARE FOR THE BASKET LUNCH.

1. Sandwiches with sliced tender meat for filling; baked apple, cookies or a few lumps of sugar.
2. Slices of meat loaf or bean loaf; bread and butter sandwiches; stewed fruit; small frosted cake.
3. Crisp rolls, hollowed out and filled with chopped meat or fish, moistened and seasoned, or mixed with salad dressing; orange, apple, a mixture of sliced fruits, or berries; cake.
4. Lettuce or celery sandwiches; cup custard; jelly sandwiches.
5. Cottage cheese and chopped green-pepper sandwiches or a pot of cream cheese with bread-and-butter sandwiches; peanut sandwiches; fruit; cake.
6. Hard-boiled eggs; crisp baking-powder biscuits; celery or radishes; brown-sugar or maple-sugar sandwiches.
7. Bottle of milk; thin corn bread and butter; dates; apple.
8. Raisin or nut bread with butter; cheese; orange; maple sugar.
9. Baked bean and lettuce sandwiches; apple sauce; sweet chocolate.

LUNCHES PARTLY OR WHOLLY PREPARED AT SCHOOL.

The basket lunch must usually be prepared at a time when the housekeeper is very busy. In places where there are shops near the

school, therefore, children are sometimes given pennies with which to buy food at noon. They like this, of course, for it is a pleasure to make their own selections and they are glad to be relieved of carrying baskets. If they could choose wisely there would be no objection to this plan and it might even be made good training in handling money and keeping accounts. In practice, however, it is found that the money is often spent in unclean places and for unwholesome foods; pickles and pies, or, at best, starchy foods and sweets are likely to make up the bill of fare, and in this way the good effects of careful feeding at home are likely to be overcome. In many places, therefore, the schools are beginning to serve noon lunches or one or two dishes which can be eaten with food brought from home.

Mothers are interesting themselves in this work not only because of its effect upon the health of their children but also because of its relation to education for home making. In their own homes they try to serve wholesome food and also to train their children to good habits in eating. They realize, however, that the meal at school is in some ways a better opportunity for training than those served at home. Unlike the other meals of the child's day, it is eaten during the hours which are set apart for education. The child's mind is, therefore, in a receptive condition, and every precaution which is taken to adapt the lunch to his physical and mental needs is likely to teach a lesson in food and nutrition, silently, to be sure, but effectively. Mothers recognize, therefore, that the lunch at school may be of assistance to them in one of their special tasks. They are recognizing, too, that the preparation and serving of lunches at school may improve the quality of teaching in home economics. Instruction in cookery as an art is, of course, most successfully given where there is a large supply of food materials and of utensils to work with and where the work itself is done with some useful and practical purpose in view. The lunch at school may, therefore, be considered a means of strengthening the courses in cookery and allied subjects. In many places it has already been introduced and is proving valuable in many ways.

It is evident from what has been said about foods in general that there is no reason why suitable lunches for children should not be supplied, even in places which serve only 5 out of 21 weekly meals, and which for that reason can not afford elaborate cooking apparatus. There are few localities where good bread can not be purchased either from public bakeries or private housekeepers. The special dishes needed to provide for "tissue building" may well be meat and vegetable stews, cocoa, milk soups or chowders, or purées of dried beans or peas, or other dishes of a similar character,

which require no oven for their preparation and only the simplest cooking equipment. Though these dishes are especially suitable because they are served hot, sandwiches with fillings of meat or meat substitutes like those mentioned in connection with the basket lunch, are by no means out of the question, even where cooking facilities are limited. It should be possible also to sell the children milk to drink, though, if this is done, the greatest watchfulness is required on the part not only of those in charge of the lunch room, but also of health officers.

The amount of protein offered for a given sum in the milk dishes mentioned above may be increased by the use of skim milk, which, as a matter of fact, has slightly more protein and mineral matter, volume for volume, than whole milk. A soup made with skim milk will contain, of course, more of these nutrients than one made with whole milk and water, half and half. However, the fact should always be kept in mind that skim milk has been handled more than whole milk, and that for this reason it is more likely to have become contaminated. Extra precautions are therefore necessary when it is used. Clean skim milk ought to be easily and cheaply obtained in country schools near farms where good cream is sold.

Fruits and raw vegetables are permissible wherever there is a good supply of water in which to wash them and care is taken to do this (see p. 7). Sweets are, of course, the easiest of all foods to obtain, since they are manufactured on a large scale and very commonly sold.

SIMPLE BILLS OF FARE FOR SCHOOL USE.

Some sample bills of fare follow. Many others equally good could be suggested.

1. Vegetable-milk soup; crackers; rolls; fruit; plain cake.
2. Meat and vegetable stew; bread and butter; sweet chocolate.
3. Boiled custard; lettuce sandwiches; fruits; cookies.
4. Dried codfish chowders; crackers; fruit; maple-sugar sandwiches.

However the school lunch is prepared, it will meet the needs of children who wish to bring part of their lunches if it contains those foods which are most difficult to carry. It is an easy matter to carry bread and butter and sweets. It is the liquid foods like milk and such foods as cooked fruits and soft fruits like berries which, though valuable, contain very little nourishment in comparison with their bulk, that cause most trouble. It happens, however, that these foods which are most likely to be needed in connection with what is brought from home are among those which must be handled with the greatest care. For this reason schools are beginning to feel responsible even for the children who buy part of their lunches only.

In the above bills of fare the first item and the fruit can easily be served by the school, and the others can be brought in the lunch basket. These bills of fare can therefore be used by those who bring part of their lunch. Where there is an oven and abundant cooking facilities the bills of fare for simple lunches prepared wholly or partly at school, on page 11, may be followed at school as well as at home.

LUNCHESES SERVED BY THE SCHOOL.

While the carrying of lunches is still by far the most common practice, taking country and town together, there are few cases in which it is not thought desirable for the school to share with the home the responsibility for the noonday meal. In some places the task for the school may be hardly more than that of providing clean and safe places for lunch baskets, where the food will not be likely to become dirty or to spoil. In others it may be practicable to provide by one means or another a hot dish with which to supplement foods brought from home. In still others, particularly where large attendance and many teachers and other workers make subdivision of labor a comparatively easy matter, it may be possible for the school to establish and maintain lunch rooms.

COSTS.

Whenever the matter of school lunches is under discussion in a community the cost must be carefully counted. Experience in rural as well as city schools has shown that expenses may be classified under the four heads: Equipment, food materials, service or hired help, and supervision. In a matter of this kind, which, from the housekeeper's standpoint, is closely related to her own problems of nutrition, the question naturally arises, What part of the expense should the school be expected to meet? It is almost universally agreed that the cost of the food materials should be covered by the sale of food and that it can be if a charge of a few cents is made for each dish. The equipment for the lunch room is usually paid for by the school board or by some organization of parents and patrons formed for the purpose of cooperation with the school. Sometimes pupils themselves raise the necessary money by means of entertainments given in the school. The cost of upkeep and new utensils, which is not often large, can usually be met from the profits on the sale of food. This leaves only the two items of service and supervision.

Service, as a rule, is reduced to a minimum, even in large city schools. Pupils are provided with trays and foods are so placed on a counter or table that they can wait on themselves. In some schools they are expected also to return the soiled dishes to an attendant. In some schools where cooking is taught the amount of hired

help is still further reduced, for the members of the cooking classes prepare and serve the lunches under the direction of the teacher as part of their class work.

The supervision of lunches is, under all circumstances, a most important matter, which bears vitally upon the problem of health in the home, for upon it depends the character of the foods selected and the cleanliness of the methods by which they are prepared and served. In this connection the report of a successful experiment in school feeding in a large city says:

The school lunch differs from the street lunch [bought at pushcarts or small shops] not only in the quantity and quality of food which children get, but also in the ideas about food which they get. Every time a child buys food he gets with it an idea about food. On the streets he gets an inferior product and a harmful idea and a low standard of food quality and care; in the school he gets a wholesome product and, if properly planned, a helpful idea about food and its care.

Supervision aims to insure this educational value for the school lunch, as well as to guarantee the wholesomeness of the lunch itself. Any means which will give children wholesome and helpful food standards are worth trying, and expense incident to such a plan may properly be charged against education and met by the public treasury.

In large cities a trained supervisor is often employed for all the lunch rooms connected with the school system. In smaller places it is customary for the teacher of domestic science to supervise the school lunch. Where the importance of the task is recognized and due allowance is made for it in planning the program of the teacher, there is no objection to this practice. On the other hand, in schools where this arrangement is adopted there is the best opportunity for making the cooking classes and the lunch room mutually helpful. Even the teacher of general branches is considered better prepared for her work if she knows something about the hygiene of foods and is prepared to supervise a lunch, as the introduction into teachers' training schools of courses in home economics testifies.

SPECIAL PROBLEMS OF THE RURAL SCHOOL LUNCH.

It is in the small country school with only one teacher that the midday meal presents the most difficult problems. The common custom is still for the pupils to bring their lunches, but there is a growing tendency to try the experiment of preparing part of the meal at school and of allowing time for serving it carefully. If rightly handled, the meal, even under the unusual difficulties presented in the rural school, may offer the most favorable of all opportunities to inculcate habits of cleanliness and to teach sanitation and simple cookery. The situation, however, will require a teacher of ingenuity and of enthusiasm for her work. The simplest of equip-

ments includes a large kettle suitable to be used on the stove which heats the schoolhouse, measuring cup and spoons, paring knife, mixing spoon, dish pans, and towels. It will usually be possible for the boys to make a set of shelves for the dishes, using box lumber if no other is available, and for the girls to make curtains or other coverings for the protection of the dishes from dust. The pupils will, as a rule, be found willing to bring plates, cups, bowls, and spoons from home, if this is necessary in order to keep down expenses. A fireless cooker can easily be made by the pupils as a class exercise.¹ In this a hot dish for lunch can be prepared before school. The fireless cooker is convenient for meat stews, meat and bean soups, cereal mushes, and many other dishes which require long cooking.

The recipes for the dishes cooked for lunch may be given to the older girls in school, discussed in class, and tried at home. The special dish for the day, which in winter is usually hot and in summer more often cold, can be prepared and served at noon by the girls in turn, working in groups. It will often be necessary to serve the food to the children at their seats, a practice which is not especially objectionable if the schoolhouse is clean and well ventilated and the desks are carefully cleaned before meals, as suggested elsewhere, and the building thoroughly screened to keep out flies, which are always dangerous around food, since they can convey to it the bacteria which cause intestinal and other diseases. At seasons when there are no flies and on days when the weather is favorable it is a pleasant change to serve the lunch out of doors. Clean hands should always be insisted upon, as well as clean spoons, dishes, etc., and individual drinking cups. Furthermore, children should be taught not to drink out of each other's cups or glasses or to use each other's spoons or forks.

The question of good food and a safe water supply can not be separated. Besides being used for drinking, the water at the schoolhouse is used for washing the hands, and if any part of the lunch is prepared there it is used in cooking and in washing dishes, and if it has in it any of the tiny forms of life which carry disease the pupils may be infected by using it in any of these ways. In schools in cities which have a good water system there is, of course, less danger than in the country, where dependence must often be placed on surface wells. When that is the case, too great precautions to provide pure, safe water either at the school or on the farm can not be taken. When there is any question of its purity, all that is used for drinking, cooking, and washing should be boiled.

It is seldom desirable to prepare more than one dish a day in a small school, and this should, for the sake of variety, differ from day to day. The others can be brought from home. Or ready-to-eat

¹ U. S. Dept. Agr., Office Expt. Stas. Syllabus 15 (1914).

foods (bread, crackers, fruit, or cakes and cookies) can be bought to round out the meal, some one in the neighborhood being usually ready to make such foods for sale if there is no shop where they can be obtained. The choice of the dish to be cooked should be determined partly by what it is possible to do in the way of cooking at the school, partly by what purchased or home-grown food is available, and what the school garden or neighboring fields or woods afford, and partly by what the teacher has learned from experience is needed to go with the foods brought from home. The noonday meal as a whole will then be appetizing and will provide all the needed nutrients as they are now understood.

A FEW RECIPES FOR SCHOOL-LUNCH DISHES.

Most housekeepers have collections of recipes for dishes of all kinds, but probably few have attempted to compile lists of dishes suitable for school lunches. A few such recipes are therefore given here, which may be suggestive.

MILK SOUPS.

The ingredients of milk soups may be grouped under four heads: (1) A liquid; (2) a starchy substance used for thickening; (3) a fatty substance; and (4) flavoring. The liquid may be milk, either whole or skim, or a mixture of two or more of the following in any proportion: Meat stock, water, cream, vegetable juice, including pulp. The starchy substance may be flour, cornstarch, or potato starch. The proportions are usually three-fourths of a level tablespoon of flour and an equal amount of butter to each cup of liquid. If starch is substituted for flour, one-half tablespoon to a cup will usually be found sufficient. An interesting school exercise may be arranged by having students make potato starch and use it for thickening these soups or in other ways.

The following recipes for soup and chowder will serve six children generously.

CREAM OF PEA SOUP.

1 can peas or 1 quart fresh peas.	2 tablespoons flour.
1 pint milk.	1 teaspoon salt.
2 tablespoons butter.	$\frac{1}{2}$ teaspoon pepper.

Heat the peas in their own liquor, or cook them in boiling, salted water until tender. Drain off the liquid and rub the peas through a strainer. Scald the milk and add to it the butter and flour rubbed to a smooth paste. Cook 1 minute, add the peas, salt, and pepper. Boil for a few minutes and serve at once.

CREAM OF TOMATO SOUP.

1 pint or 1 can tomatoes.	1 quart milk.
2 tablespoons butter.	Sprig parsley.
1 tablespoon flour.	$\frac{1}{2}$ teaspoon white pepper.
1 teaspoon sugar.	$\frac{1}{2}$ teaspoon soda.
1 teaspoon salt.	

Cook the tomatoes slowly with the flavorings for 10 minutes and rub through a strainer. Scald the milk, thicken with the flour and butter rubbed to a paste; reheat the tomatoes and add the soda; combine with the milk and serve at once.

QUICK TOMATO SOUP.

1 pint or 1 can tomatoes.	1 teaspoon salt.
1 quart water.	$\frac{1}{2}$ teaspoon pepper.
4 tablespoons butter.	1 tablespoon chopped onions.
4 tablespoons flour.	

Mix the water, tomato, and seasonings. Heat to the boiling point; add butter and flour rubbed to a paste and cook a few minutes. Strain and serve.

CHOWDERS.

Fish or clam chowders and oyster stews, though common and suitable in regions where fresh sea food is abundant, would not be readily obtainable dishes for school lunches in many localities. There are, however, certain similar dishes which can easily be prepared in the school and which are attractive and wholesome. The ingredients are milk, whole or skim; a fatty substance, which is usually salt pork, though butter may be used; potatoes or crackers, often both; and, in addition to these, one of the following: Fish, which may be either fresh or salt; green corn, fresh or canned; parsnips, vegetable oysters, kohl-rabi, or celery. A chowder consisting mainly of milk, potatoes, and crackers, and flavored with a little salt codfish is perhaps the most economical of these dishes.

SALT-CODFISH CHOWDER.

1 $\frac{1}{2}$ ounces or 1 $\frac{1}{2}$ cubic inches fat salt pork.	1 quart milk.
1 tablespoon chopped onion.	$\frac{1}{2}$ pound salt codfish, or just enough to flavor.
3 cups potatoes, cut into small pieces.	$\frac{1}{2}$ pound crackers.

Break the codfish into small pieces, soak it in lukewarm water until it is soft and the salt has been removed. Cut the pork into small pieces and cook it until a delicate brown, adding the onions during the last part of the cooking. To the pork and onions add the potatoes; cover with water and boil them until tender. Add the milk and fish and reheat. Add the crackers shortly before the chowder is served.

CORN CHOWDER.

The same general directions can be followed for making corn chowder as for making salt-codfish chowder. One can of corn or 1 pint of fresh corn is sufficient for the amount given above. If fresh corn is used, it should be cooked with the potatoes.

VEGETABLE CHOWDER.

Any one, or a combination of two or more of the vegetables mentioned on page 20, may be used as suggested for fresh corn (i. e., cooked with the potatoes) in making a chowder.

POTATO CHOWDER.

6 medium-sized potatoes, sliced.	1 tablespoon flour.
$\frac{1}{2}$ pound salt pork, cut into dice.	1 pint milk.
1 tablespoon chopped onion.	1 pint water.
1 tablespoon butter.	1 teaspoon salt.

Fry the pork and onions together until both are a delicate brown. Put a layer of the sliced potatoes into a kettle, then a layer of onions and pork, and sprinkle with salt. Repeat this until those materials are all used. Pour over them the grease from the pan in which the pork and onions were fried and add the water. Cover and simmer 20 minutes, or until the potatoes are tender. Thicken the milk with the flour mixed with the butter and pour it over the potatoes. Stir carefully, so as not to break the potatoes. Serve very hot.

BROWN STEW.

For this dish the cheaper and less tender cuts of beef, such as the rump and round, can be used. Remove the meat from the bone and cut it into small pieces. Dredge with flour and cook in a small amount of fat until it is well browned. Add hot water, about 1 quart to every pound of meat; season with salt, pepper, and onion; and cook slowly for an hour. The meat should be very tender and the gravy thick. Tomato and other vegetables may be added while the stew is cooking. An allowance of 1 pound of round steak for 10 children will, according to a general estimate, equal in protein value a glass of milk for each.

SOUPS MADE FROM DRIED BEANS, PEAS, OR COWPEAS.

There are a great variety of soups of high nutritive value that can be made from dried navy beans, black beans, lentils, cowpeas, or other legumes. The vegetables should be first soaked in water for several hours, overnight being usually the most convenient time. When they are thoroughly soaked, the water should be poured off and fresh water added. They should then be cooked until tender, with a little onion, celery, or other highly flavored vegetable, and salt, then put through a strainer to remove the skins. The juice and pulp should then be either diluted or boiled down to the proper consistency for a soup and should be bound with a mixture of flour and butter, as milk

soups are. An ounce of dried beans is very nearly equal in protein value to a glass of milk, though the protein is not so completely digested.

GREENS.

Greens should be thoroughly washed in several waters. A good rule to follow in washing and also in removing cooked greens from the water in which they have been cooked is to lift the greens out rather than to pour the water off. When the water is poured off, the sand and grit which have sunk to the bottom of the pan are likely to get on the greens again. To preserve the color of greens add about one-eighth of a teaspoon of soda to each quart of water in which they are cooked; to preserve flavor avoid cooking longer than necessary to make them tender. Remove the greens from the water and season with salt and a little pepper; or reheat with a little fat or butter. The addition of butter, cream, oil, or savory fat to the cooked greens increases nutritive value and also improves flavor.

BOILED AND CODDLED EGGS.

The most common way of preparing eggs is by cooking them for three minutes in boiling water. By this process the yolk is left entirely uncooked and the white is more cooked than many people think desirable. A better way is to place the eggs in hot water, remove them from the stove, and allow from six to eight minutes for cooking. Much will depend upon the temperature of the eggs and the amount of water used. In most cases, however, the following method will be found satisfactory: Bring to the boiling point one cup of water for each egg to be cooked, put the eggs into the water, remove from the fire, and cover the pan closely. Leave the eggs in the water for from six to eight minutes. "Hard-boiled" eggs can be prepared in the same way by allowing a longer time.

BAKED OMELET WITH GREENS.

1 quart or $\frac{1}{2}$ pound spinach, kale, Swiss chard, or other greens.	$\frac{1}{2}$ cup liquid (milk, cream, water, soup stock, vegetable juice, or a mixture of two or more of these).
$\frac{1}{2}$ cup butter or other fat.	4 eggs.
$\frac{1}{2}$ cup flour.	1 teaspoon lemon juice or vinegar.
1 teaspoon salt.	
$\frac{1}{2}$ teaspoon pepper.	

Wash the greens with great care, boil until tender (which will take 20 to 25 minutes) in the least possible amount of water; drain and chop fine. A meat chopper will be found convenient for the purpose. Melt the butter, add the flour, and cook for about one minute. Add the milk, stirring constantly, and cook until the mixture is smooth and thick. Add the chopped greens and the egg yolks. un-

beaten. Beat the whites of the eggs stiff and add them to the other mixture by the cutting and folding process. Pour into a buttered baking dish and cook in a slow oven for 30 minutes, or until firm and brown. Serve at once.

RICE OR MACARONI AND CHEESE.

Boiled rice or macaroni can be heated with enough grated cheese added to flavor it. If preferred, it may then be browned in the oven before serving.

BEAN, PEA, OR COWPEA LOAF.¹

Any of the dried vegetables mentioned in the recipe on page 21 can be made into a loaf. They should be soaked and thoroughly cooked as for the soup, but with less water, and it is well not to add the seasonings until after the vegetables have been put through a sieve. Then chopped celery, green peppers, onions, pimientos, or grated cheese can be added and the mixture browned in the oven. This dish can be served either hot or cold.

SAUCES.

There is a great variety of sauces which can be used in the home to serve with meat or vegetables and can also be used in making sandwich fillings. In a general way, they are made like milk soups, excepting that more flour is used. Two tablespoonfuls of flour and 2 tablespoons of butter or other fat are usually allowed for each cup of liquid. This liquid may be water, broth, tomato juice, milk, cream, the water in which vegetables have been cooked, or a combination of two or more of these.

TOMATO SAUCE.

1½ cups tomato juice.	1 slice onion.
2 tablespoons flour.	Sprig parsley.
2 tablespoons butter.	½ teaspoon salt.
½ teaspoon pepper.	

Add the seasonings to the tomato juice and simmer until the liquid has been reduced to about 1 cup. Melt the butter in a saucepan, stir in the flour, and when this is smooth add the strained tomato juice. Cook for a few minutes or until smooth and thick. The tomato juice may be used plain, omitting the first cooking with the seasonings.

This will provide a tablespoon for each of 16 people.

WHITE SAUCE.

2 tablespoons butter.	½ teaspoon salt.
2 tablespoons flour.	½ teaspoon pepper.
1 cup milk.	

Melt the butter, stir in the flour, and cook until smooth, but not brown; add the milk slowly and cook until smooth and creamy. Season.

This makes 12 portions of 1 tablespoon each.

¹ U. S. Dept. Agr., Farmers' Bul. 559 (1913).

SALAD DRESSING.

Of numerous salad dressings, the following are well suited to school-lunch use. As they are used chiefly for moistening sandwich fillings, it is difficult to give the number of people they will serve.

OIL AND VINEGAR DRESSING.

$\frac{1}{2}$ teaspoon salt.	6 tablespoons oil (olive, cotton-
2 tablespoons vinegar.	seed, peanut, or other).
Few grains cayenne.	

Mix the ingredients and beat them until they are well mixed.

COOKED SALAD DRESSING.

2 egg yolks.	1 teaspoon salt.
$\frac{1}{2}$ cup milk.	$\frac{1}{2}$ tablespoon flour.
$\frac{1}{2}$ cup vinegar.	1 teaspoon mustard.
2 $\frac{1}{2}$ tablespoons butter.	

Mix all the dry ingredients with the egg yolks; beat until light and add the melted butter, cold milk, and hot vinegar. Cook in double boiler until the mixture coats the spoon. If it curdles, place the boiler at once into a pan containing cold water and beat until smooth. One whole egg may be used in place of two yolks.

MAYONNAISE DRESSING.

1 egg yolk.	1 cup salad oil (olive, cotton-
1 teaspoon salt.	seed, peanut, or other).
$\frac{1}{2}$ teaspoon mustard.	2 tablespoons lemon juice and
$\frac{1}{2}$ teaspoon cayenne.	vinegar.
1 tablespoon sugar.	

Put the egg yolk into a cold bowl; add the seasonings and mix until smooth; then add the oil, one drop at a time, stirring constantly. As it thickens, thin with vinegar and lemon juice.

SWEETS.

Several recipes for simple sweets follow:

FRUIT AND NUT CONFECTION.

1 pound figs.	1 pound nut meats.
1 pound dried prunes or seedless raisins.	Confectioners' sugar.

Wash, pick over, and stem the fruits and put them with the nut meats through a meat chopper, and mix thoroughly. Roll out to a thickness of about one-half inch on a board dredged with confectioners' sugar, and cut into small pieces. If this candy is to be kept for some time, the pieces should be separated by means of paraffin paper.

Provides 24 2-ounce portions.

CANDIED FRUIT PEEL.

The candied peel of oranges, grapefruit, kumquats, and other citrus fruits make a good sweet which is economical, because it utilizes materials which might otherwise be thrown away. Its preparation makes an interesting school exercise. The skins can be kept in good condition for a long time in salt water,

which makes it possible to wait until a large supply is on hand before candying them. The salt water takes out some of the bitter taste. The skins should be washed in clear water after removal from the salt water, boiled until tender, cut into small pieces, and then boiled in a thick sugar sirup until they are transparent. They should then be lifted from the sirup and allowed to cool in such a way that superfluous sirup will run off. Finally they should be rolled in pulverized or fine granulated sugar.

HONEY CAKES.

Simple honey cakes, such as those for which recipes are given in one of our earlier publications,¹ are convenient for use in school lunches, for, because of their unusual keeping qualities, a large supply can be made up at one time. Honey drop cakes and hard honey cake are especially suitable.

BOILED CUSTARD.

2 cups hot milk.
3 egg yolks.
 $\frac{1}{4}$ cup sugar.

Speck salt.
Flavoring.

Beat the yolks slightly and add the sugar and salt. Pour the hot milk over this mixture, stirring constantly. Cook in a double boiler, stirring until the mixture thickens and will form a coating on the spoon. Cool and flavor. If the custard curdles, beat with an egg beater.

If the whites of the eggs are to be used, beat them very stiff and add three tablespoons of powdered sugar. Place by spoonfuls on water which is hot but not boiling. Cover the dish. Test occasionally by putting a knife into it; when it is done nothing will stick to the knife. Remove from the water with a wire egg beater or split spoon and place on top of the custard.

SUMMARY.

The problem of planning, preparing, and serving the midday meal for the child in school will vary with the region, the location and equipment of the school, and many other factors. No general discussion can give detailed advice suited to all different conditions.

In the foregoing pages matters of fundamental interest are considered. The child's dietetic needs are outlined. Food combinations are suggested, which will be of use in schoolroom menu making, and directions are given for making a number of dishes which may be taken as examples of those which can be prepared at school. Such dishes should be supplemented by bread, butter, fruit or vegetables, and sweets, which can be brought from home or prepared at the school, if this is more convenient. Reasons are given for the recommendations that the lunch at school receive thought and attention at all times and that, wherever children are unable to go home at noon, the school lunch form a definite part of the educational program.

¹ U. S. Dept. Agr., Farmers' Bul. 653 (1915), pp. 17, 20.

An adequately supervised lunch at school, whether prepared there or at home, or partly in the one place and partly in the other, is conceded to contribute to the child's health and to his readiness to learn. Furthermore, it may be made to enrich the content of education by directing attention to the importance of food problems.

**PUBLICATIONS BY THE U. S. DEPARTMENT OF AGRICULTURE OF
INTEREST IN CONNECTION WITH THIS BULLETIN.**

- Farmers' Bul. 85, Fish as food.
Farmers' Bul. 121, Beans, peas, and other legumes as food.
Farmers' Bul. 128, Eggs and their uses as food.
Farmers' Bul. 249, Cereal breakfast foods.
Farmers' Bul. 256, Preparation of vegetables for the table.
Farmers' Bul. 293, Use of fruit as food.
Farmers' Bul. 295, Potatoes and other root crops used as food.
Farmers' Bul. 298, Food value of corn and corn products.
Farmers' Bul. 332, Nuts and their uses as food.
Farmers' Bul. 363, The use of milk as food.
Farmers' Bul. 375, Care of food in the home.
Farmers' Bul. 389, Bread and bread making.
Farmers' Bul. 391, Economical use of meat in the home.
Farmers' Bul. 413, The care of milk and its use in the home.
Farmers' Bul. 487, Cheese and its economical uses in the diet.
Farmers' Bul. 526, Mutton and its value in the diet.
Farmers' Bul. 535, Sugar and its value as food.
Farmers' Bul. 559, Use of corn, Kafir corn, and cowpeas in the home.
Farmers' Bul. 565, Corn meal as a food and ways of using it.
Farmers' Bul. 653, Honey and its uses in the home.
Weekly News Letter, 2 (1915), No. 50, p. 7, Use of sweet peppers.
S. R. S. Doc. 8, Ext. N.—Form O-4, Potato starch and its use in the home.
S. R. S. Doc. 16, Ext. N.—Form O-7, Recipes for the use of potatoes and home-made potato starch.
S. R. S. Doc. 17, Ext. N.—Form NR-24, Home canning club instructions to save fruit and vegetable waste. (Contains a list of some wild and cultivated greens.)
Bur. Plant Indus. [Circ.] 775, Use of vegetables from winter garden.
Bur. Plant Indus. [Circ.] 776, How to build and use a fireless cooker.
Bur. Plant Indus. [Circ.] 782, Peppers.
Office Expt. Stas. Syllabus 15, Illustrated lecture on the homemade fireless cooker.

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UNITED STATES DEPARTMENT OF AGRICULTURE



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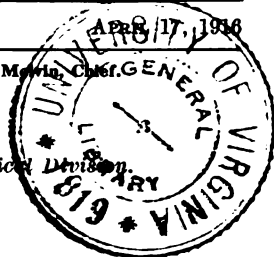
WASHINGTON, D. C.

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Contribution from the Bureau of Animal Industry, A. D. Mearns, Chief.

SHEEP SCAB.

By MARION IMES, *Veterinary Inspector, Zoological Division.*



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HISTORY AND CHARACTERISTICS.

Scabies in sheep, commonly known as sheep scab, is one of the oldest known, most contagious, and most injurious diseases affecting sheep. Its history dates back to the earliest ages of civilization. It is a highly contagious skin disease, easily transmitted from one sheep to another, and spreads very rapidly after being introduced into a flock. It is caused by a small animal parasite, commonly known as a "mite," which lives on the skin. Although the disease is not hereditary, it is possible for a new-born lamb to become infected from a diseased mother shortly after birth, and this fact has led some sheep owners to think it is hereditary. Besides common sheep scab there are several other varieties of scab affecting sheep, each caused by a distinct species of mite, but they are of comparatively little importance and will not be considered in this bulletin.

When allowed to spread, sheep scab causes great financial loss to the industry. These losses are caused by (1) a decrease in the quantity of wool produced, (2) loss in weight and general condition from irritation and other effects of the disease which render the animals unthrifty, and (3) the death of large numbers of infected sheep.

NOTE.—This bulletin is intended for the information of sheep raisers and live-stock sanitary officers concerned in the prevention, cure, or eradication of sheep scab. It supersedes Farmers' Bulletin 159.

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While the disease is highly contagious, insidious in its nature, and severe in its effects, it yields readily to proper treatment and is easily cured. A sheep owner should never allow scab to remain in his flock, as it can be easily eradicated by proper dipping.

Common scab was formerly the greatest drawback to the sheep industry of the United States, but during the past decade great progress has been made in its eradication. The system of grazing sheep on the open ranges of the western part of the United States was such that the flockmasters had great difficulty in keeping the flocks free from scab. The sheep were very frequently exposed to the disease by infectious ranges and trails, "picking up strays" from infected flocks, and in many other ways. It became desirable for the Department of Agriculture to extend aid to the industry by controlling the interstate movement of sheep to prevent the carrying of the infection from one State to another. Arrangements for cooperative work with the live-stock sanitary authorities of the various States concerned were made by the Bureau of Animal Industry with the object in view of completely eradicating the disease. This work has been in progress for about 10 years, and during that time the disease has been reduced to a minimum over the entire area and nearly all the formerly affected States have been released from quarantine. The disease has been so nearly eradicated that at present the economic losses from this cause are practically nil. In view of the highly contagious nature of the disease, however, it is very important that the work of eradication be pushed to completion in order to prevent the disease from again becoming prevalent.

With our present knowledge of and experience in sheep-scab eradication work, it is comparatively easy to reduce the infection to a point where it ceases to cause economic loss, but the complete eradication of the parasite over such vast areas is a problem requiring patience and diligence. Where the eradication work is supervised by a well-organized force of trained field men, the percentage of infected flocks can be reduced very rapidly until it reaches a fraction of 1 per cent; but to reduce that fraction to zero requires very careful and systematic work, with the full cooperation of the sheep owners. As soon as the disease is reduced to a point where the economic loss is little or nothing, many sheep owners lose sight of the importance of continuing systematic efforts for complete eradication. It is necessary, however, for the protection of the sheep industry that the efforts be continued until the pest is completely eradicated.

Since the quarantine has been removed and compulsory dipping discontinued the sheep owners in some communities have allowed their dipping vats to go to ruin through lack of use and care. All

vats should be kept in repair, and for several years to come each sheep owner will probably find it wise to dip his sheep at least once a year as a precautionary measure.

THE PARASITE WHICH CAUSES SHEEP SCAB.

The mites which cause common sheep scab are small insectlike parasites known technically as *Psoroptes communis ovis* or *Psoroptes ovis*, the male measuring when fully grown only about one-fiftieth and the female one-fortieth of an inch in length. They may be seen with the naked eye, particularly if they are placed on a dark background. They occur on any portion of the body covered by wool, but are most common where the wool is thickest; they are the sole cause of the disease. (See figs. 1 and 2.) Their destruction is followed by recovery, whereas any treatment which does not destroy them fails to cure scab.

LIFE HISTORY OF THE SCAB MITE.

The various stages in the life history of the scab mite are all passed on the body of the sheep. After the mating of the sexes the females deposit their eggs in clumps

on the skin at the base of the wool fibers. Each female may deposit at least as many as 15 eggs, which hatch after 3 or 4 days' incubation; the young mites grow to maturity in 7 or 8 days and in 3 or 4 days more mate and deposit their eggs. The females apparently live but a short time after they have laid their eggs.

According to the figures above, which are those given by Gerlach, the entire life cycle is completed in 12 to 15 days. Other observers state that the period of incubation of the eggs may be as long as 10 days, but this is probably exceptional, and 7 days may be assumed to be the usual maximum limit of incubation. Assuming that each female has 15 offspring and taking 15 days as the period required for each brood of eggs to hatch and the young mites to develop

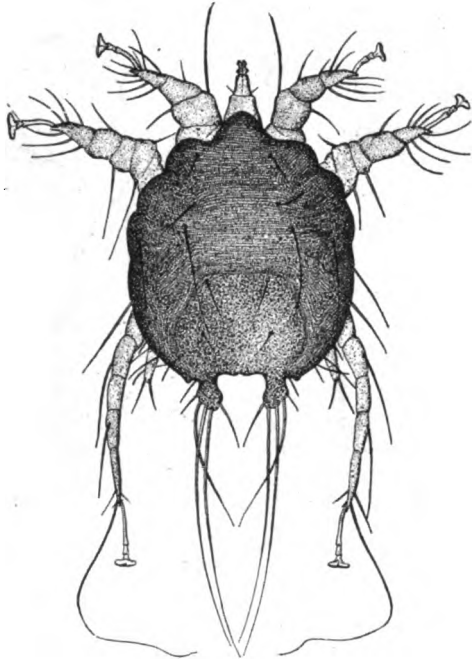


FIG. 1.—Sheep-scab mite (*Psoroptes ovis*). Male. Dorsal view, greatly enlarged. (After Salmon and Stiles, 1898.)

to maturity and deposit another brood of eggs, Gerlach has estimated that the sixth generation from one pair of mites, which may appear in 90 days, may consist of as many as a million and a half individuals. Another 15 days may bring the number up to 15,000,000 and 15 days more to 150,000,000. This calculation, though theoretical and only approximate, gives an idea of the rapidity with which these parasites multiply and shows that a few mites gaining a foothold on one or two sheep may in a short time have descend-

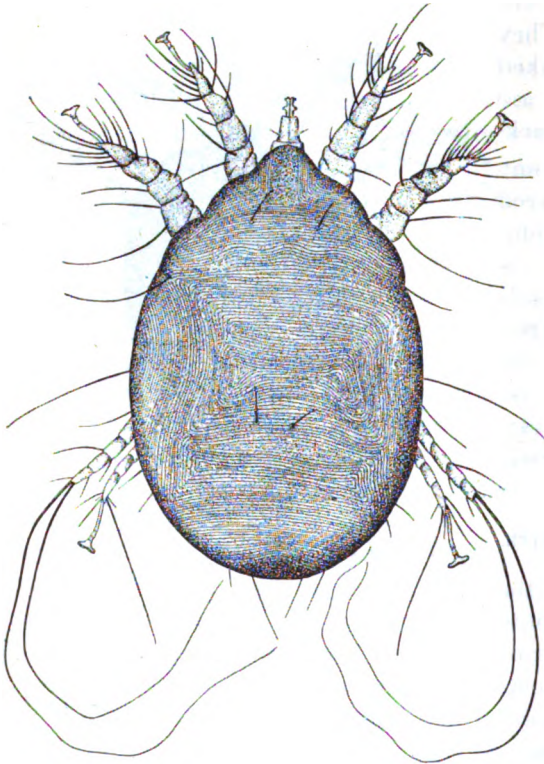


FIG. 2.—Sheep-scab mite (*Psoroptes ovis*). Female. Dorsal view, greatly enlarged. (After Salmon and Stiles, 1898.)

ants enough to infest heavily the entire flock. The importance of prompt treatment when scab is discovered in a flock, or if sheep have been exposed to infection, is evident.

Some of the points in the life history of the scab mite, as outlined above, have a certain bearing on the question of the time which should elapse in the treatment of sheep scab between the first and second dippings. It has been found that a single dipping usually fails to free a flock from scab, the apparent reason being either that all the females in the course of de-

positing eggs at which time they appear especially tenacious of life) or all the eggs already deposited have not been destroyed by the dipping; consequently, after the eggs which may have escaped the first dipping have had an opportunity to complete their incubation, it is essential to dip the sheep again. It is also essential that the second dipping take place before any mites which may hatch out after the first dipping have had time to become mature and deposit more eggs. As the eggs on the body of the host usually require 4 days' incubation, sometimes a week, and probably never more than 10 days, and as 10 to 12 days are necessary for

the young mites after hatching to grow to maturity, mate, and deposit their eggs, it would appear that the best time for the second dipping is about 10 days after the first, as all the eggs will have hatched, while practically none of the new generation of mites will have developed sufficiently to deposit eggs. Practical experience has shown that the second dipping may be delayed until the fourteenth day without unfavorably affecting the results of the treatment, but wherever possible it is preferable to follow the 10-day rule.

VITALITY OF SCAB MITES.

The species of mite which causes common sheep scab is unable to propagate itself except on the bodies of sheep, its natural host. Mites of this species, however, when removed from the host, are able to live for some time, the period of survival varying under different conditions.

From a practical point of view and because of the spread of infection from diseased to healthy sheep through the medium of stables, pastures, etc., and the fact that the mites or their eggs, scattered by diseased sheep, may survive until picked up by healthy sheep, this question of the length of time that mites or their eggs may retain their vitality when away from the host is obviously an important one. Various data which have been collected relative to this subject show that mites removed from the body will commonly live from 2 to 3 weeks, and cases have been recorded of their survival for as long as 2 months. It appears certain that under natural conditions they sometimes live much longer.

A dry atmosphere is very unfavorable to their existence away from their host. Other things being equal, scab mites will live longer off the body in a cool, moist atmosphere than in a warm, dry one.

Owing to varying conditions which may affect the longevity of mites and the vitality of their eggs when away from their natural host, it is impossible to make definite statements as to the length of time infection of pastures and buildings may persist after sheep have been removed from them. It is fairly safe to assume, however, that a month or two will suffice to free open pasture from infection, but that buildings, pens, bed grounds, etc., will not be safe even after a year or more; consequently these latter places, when they have been occupied by infested sheep, should be abandoned, destroyed by burning, or thoroughly cleaned and disinfected before they are used for clean sheep.

SYMPTOMS OF SCAB.

When the scab mite finds lodgment on a sheep it pricks the tender skin to obtain food, and in so doing probably introduces a poisonous saliva into the wound. A slight inflammation is caused, made man-

ifest by a reddening of the skin. This stage of the disease is rarely if ever detected by casual observation. (See fig. 3.) As the mites multiply, large numbers of small wounds are made in the skin and are followed by intense itching, with formation of papules, inflammation, and exudation of serum. The serum, which oozes to the surface, becomes mixed with the natural excretions and particles of dirt, and more or less infested with microorganisms. This mass soon hardens into crusts or scabs in the wool; these in the early stages are of a yellowish color, but as the disease advances and the scabs thicken they become dark from blood stains, dirt, and other causes. When the disease begins only a small pimple can be seen, but as the mites

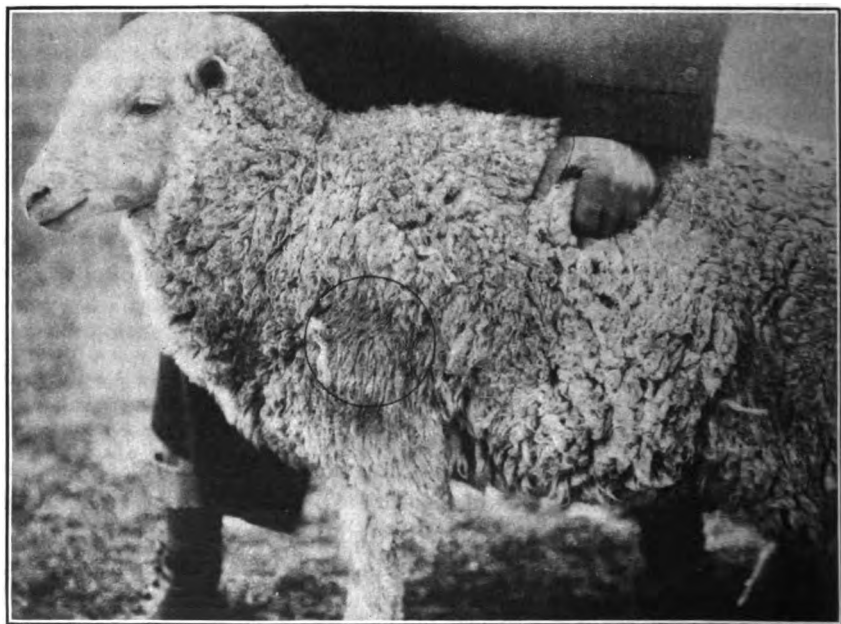


FIG. 3.—First stage of scab on shoulder, showing natural position of wool disturbed by biting and scratching.

multiply they seek the healthier parts around the edges of the diseased area, and thus the lesion or scab is continuously enlarged. The areas of the skin affected become hardened and thickened. This is readily detected by pinching up a portion and comparing it with the surrounding healthy skin. Other conditions resembling scab rarely if ever cause this characteristic, uniform thickening of the skin. When the affected skin is pinched or handled, the sheep as a rule turns its head toward the lesion, thrusts out the tongue, licks the lips, and champs the jaws.

The intense itching causes the sheep to become restless. This irritation is particularly noticeable after the animals have been

driven, as itching is more intense when they are heated. They bite and scratch themselves and rub against any available object, including other members of the flock. The natural position of the wool is disturbed by these efforts to obtain relief, and as more or less wool is pulled out, the fleece assumes the condition known as "broken." At first the wool on the affected parts, if within reach of the mouth, is seen to have been chewed and some of it pulled out. The wool on affected parts not within reach of the mouth has a discolored, worn, or ragged appearance, caused by scratching with the hind feet or

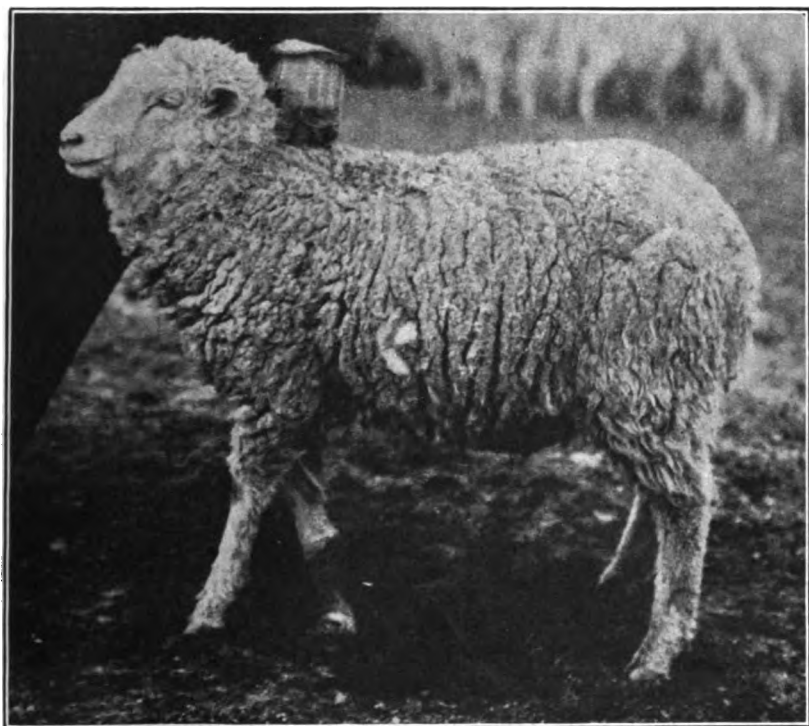


FIG. 4.—First break in fleece, early stages of scab, lesions about the size of a pea.

rubbing against other objects. At this stage the marks of the mouth or feet on the fleece or the disturbed position of the wool may be the only visible symptoms, unless close examination is made of each individual sheep. (See fig. 5.) As the disease advances increasingly large areas become entirely denuded of wool. Scabs fall and are replaced by thicker and more adherent crusts. The skin finally becomes more or less bare, tumefied, is greatly thickened, and may crack and bleed. Unless properly treated many of the animals will die.

DETECTING SCAB IN THE EARLY STAGES.

The most certain diagnosis consists in demonstrating the parasite (*Psoroptes communis ovis*) which alone causes the disease. To obtain specimens of live mites one of two methods is usually employed; first, lifting the mite from the surface of the skin with the point of a knife blade, and second, taking scrapings of wool and epidermis containing the mites and isolating the parasites from such scrapings. To obtain mites with a knife blade, good light is necessary. The wool around the affected area is suddenly parted with the forefinger and thumb, and by the aid of a magnifying glass or even with the naked eye the mites can often be seen moving rapidly away

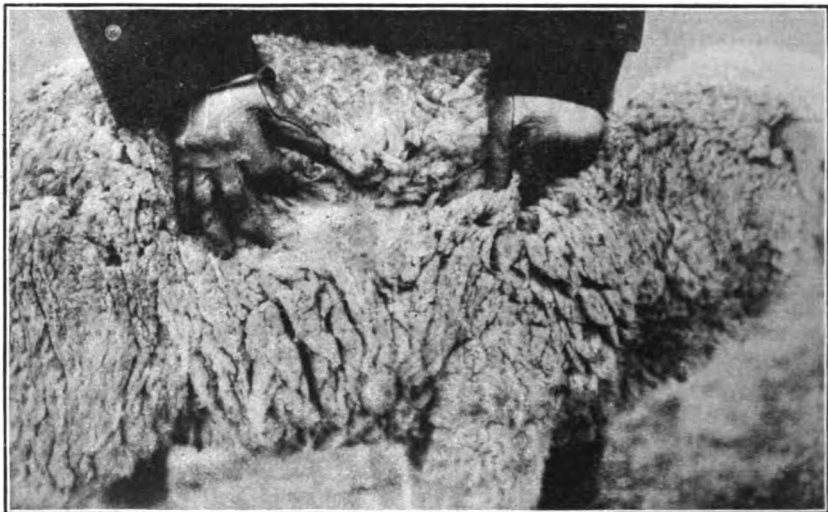


FIG. 5.—Characteristic scab lesion in early stages of the disease.

from the light. When they are thus found they can often be picked up on the end of a knife blade.

When scrapings are taken the outer edges of the infected areas should be scraped with a blunt-edged knife. The mass of scrapings is transferred to a smooth, black surface such as the brim of a black hat or a piece of black paper. To make the mites active the temperature should be approximately the temperature of the body. Spreading the scrapings in the bright, warm sun or near artificial heat will usually cause the mites to become active, and they can be seen as minute gray moving bodies against the dark background. They are quite plainly visible under a low-power hand lens.

When the mites are producing active irritation the surface of the skin in the immediate vicinity of the lesion is greasy and appears bright and glistening or white and glossy. Under such conditions

the mites are usually present in large numbers and are easily found. On the other hand, if the lesion is dull and dry in appearance it indicates that the mites are inactive at that point and that they will be difficult to find. Usually the latter condition is found in the center of a patch of scab of comparatively long standing or where the mites have been destroyed or rendered dormant. The white, glossy appearance is seen in cases of recent infestation or on the outer edges of old lesions. It is often difficult to find mites during cold, stormy weather, as they apparently leave the infested area, where the wool is light, and seek shelter where it is heavier.

Any condition which causes the sheep to bite and scratch should be investigated at once and the cause definitely learned. Scab on certain parts of the sheep's body may be overlooked. It is usually found on the back or sides, but may start on any part of the body. Lambs are sometimes infected around the head between the horns and ears, and as these parts are frequently covered with dirt the lesions may not be noticed unless close examination is made. Scab mites are sometimes found in the ear and in the groove beneath the eye, which may explain some cases of fresh outbreaks after treatment, the mites in these places surviving imperfect dipping. On wrinkled breeds, and especially on the bucks of these breeds, scab may be so well concealed in the wrinkles as to render its detection difficult. The breasts and bellies of suspected bucks of all breeds should be closely examined, as these parts are frequently affected. In some cases a considerable area of scab may be present, especially on the back of the sheep, without causing a break in the fleece. In these cases, most often found in tight-wool sheep, the wool will be "raised" from the skin but is held so firmly by the surrounding wool that it may escape detection. Bucks are not so sensitive to the effects of scab as other sheep; consequently they may have scab a long time without showing any breaks in the fleece. In some cases they do not bite or rub the affected parts enough to cause dislodgment of the wool. (See fig. 7.)

Well-advanced cases of hard scab are usually easy to diagnose, but the disease should never be allowed to reach this stage, as it entails heavy loss to the owner and the entire premises may become infectious. The experienced sheep grower realizes that a case of common scab, if neglected and allowed to spread, will materially reduce the profits and often place the balance on the wrong side of the ledger.

CONDITIONS WHICH MAY BE MISTAKEN FOR SCAB.

Any parasite or condition which causes itching and thus leads the sheep to scratch themselves may temporarily be mistaken for scab, but if it is remembered that scab is caused only by scab mites, and

that unless they are present there can be no scab, the diagnosis is rendered more simple.

Common sheep scab may be differentiated from conditions caused by other parasites, such as sheep ticks, common ticks, and lice, by finding the parasite and by the nature of the lesion. If the itching is caused by ticks an examination will reveal the ticks. (See fig. 8.) They are much larger than the scab mites and are of a dark-brown color. If lice cause the sheep to scratch they can be found on examination, and as they are much larger than a scab mite they are

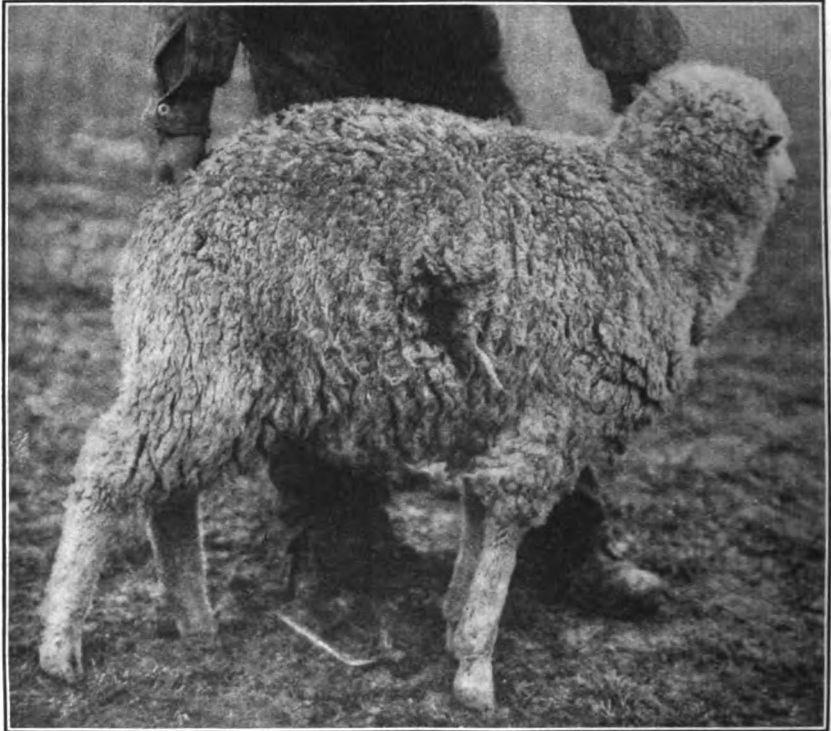


FIG. 6.—A case of scab more advanced than that in figure 5, showing area defoliated of wool.

easily identified. Ticks and lice do not, as a rule, produce pronounced local lesions. They move more or less from place to place on the skin, so that scratching and biting is not repeated persistently in one place as in the case of scab. It should be remembered, however, that ticks or lice may be present on scabby sheep and that their presence in itself is not enough to warrant the exclusion of scab as a possibility in the diagnosis.

Bearded seeds of grass and weeds, thorns and spines from cacti and various other plants, often become lodged in the fleece and prick

the skin, setting up an irritation which causes the animal to bite and scratch. In this way wool is pulled out in small tags and the fleece often presents a ragged or broken appearance. The bearded seeds or thorns sometimes penetrate the skin, causing an abscess. On close examination the causative agent can usually be found and removed.

Eczema, wildfire, summer sores, inflammation of the sebaceous glands, rain rot, shear cuts, sunburn, and the effects of alkali dust on areas denuded of wool may be mistaken for scab by those who are inexperienced.



FIG. 7.—Scabby buck with entire hind quarters and flank affected. (The discolored area is due to dip stain from hand dressing.)

Eczema is an inflammatory condition of the skin and is usually accompanied with itching and the formation of crusts and in some cases scabs. It is differentiated from scab by the fact that it does not cause the characteristic thickening of the skin found in common scab and the mite is not present.

Wildfire, so called, affects sheep mainly in the Northwestern States. It causes the sheep to bite and scratch, and the pulling of the wool causes breaks in the fleece. Upon examination of the infected sheep the skin is found to be red and inflamed but is soft to the touch. It is not hardened and thickened, as in scab.

A condition commonly known as summer sores exists among sheep in some localities. It appears as an irritating sore on the skin. The sheep bite and scratch the affected parts until the wool is pulled out and the skin becomes raw and bleeding. It is differentiated from scab by the absence of the scab mite, the character of the lesion, and the fact that the skin is not thickened in the characteristic manner.

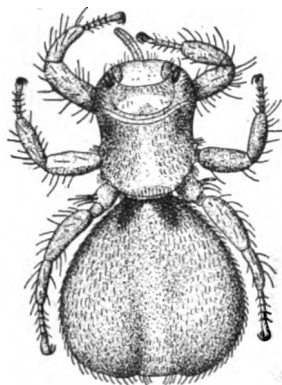


FIG. 8.—Sheep tick (*Melophagus ovinus*). Male. Dorsal view, enlarged. (From Curtice, 1890.)

Inflammation of the sebaceous glands may be mistaken for scab. There is severe itching, the skin is red and sensitive, and there is an excretion of a strong-smelling, yellowish, viscid yolk. The skin does not have the characteristic appearance of scab and the mite is not present.

In rain rot, a condition occurring in rainy weather, an eruption may appear on the skin which might be mistaken for scab. There is, however, no parasite present, itching is absent, and the trouble disappears when dry weather comes.

Shear cuts, sunburn, and the effects of alkali on the skin are conditions found in sheep after shearing. They are easily differentiated from common scab by the character of the lesions and the absence of the scab mites.

CONTAGIOUSNESS OF SCAB.

Sheep scab is exceedingly contagious and is transmitted by direct contact with animals or objects that are carriers of the mites. Although unable to propagate except on sheep, the mites may be harbored temporarily by animals other than sheep and may live on goats for a long period. Consequently, in the eradication of the disease, goats belonging to a flock of scabby sheep should be handled and treated in the same way as the latter. Sheep scab spreads through a flock very rapidly, once it is introduced. The contagion may be direct, by contact of one sheep with another, or indirect, from tags of wool, fence posts against

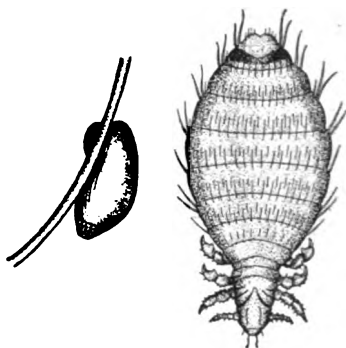


FIG. 9.—Sheep foot louse (*Haematopinus pedalis*). Adult female and egg, enlarged. (From Osborn, 1896.)

which infected sheep have rubbed, or from places where they have been. A flock of scabby sheep will infect the roads, trails, sheds, yards, bed grounds, pastures, ranges, and the ground around the watering places. It is therefore important that the flock receive proper treatment as soon as the disease appears, before the infection becomes scattered over the premises.

The transmission of the disease to a flock is not limited to any one season of the year, although during the hot summer months few cases of recent infestation are noticed in the range sections. Scab often remains dormant during dry summer months and assumes the appearance of having been cured, but usually becomes evident again with the advent of cold, rainy weather.

Symptoms of scab may develop within a week after healthy sheep have been exposed to it. The usual practice is to consider that the disease may develop at any time within 30 days after exposure, although, under certain conditions, the development may be retarded even longer. The disease develops more rapidly in the fine-wool breeds, such as the Merino and Rambouillet, than in the loose-wool breeds having an open fleece, and the fine-wool sheep also succumb more rapidly to an attack, so that treatment must be very carefully applied if the results are to be successful. The fleece of the fine-wool sheep contains much grease or yolk, which in a measure hinders the penetration of the dip.

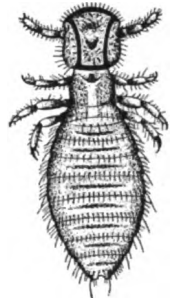


FIG. 10. — Sheep louse (*Trichodectes sphaerocephalus*). Adult female, enlarged. (After G. Neumann, 1892.)

The effect of sunlight on the scab mite is apparently an important factor, since the disease develops most rapidly and is seemingly most severe in its effects on the fine-wool sheep, and is diminished in its effects and retarded in its development in a direct ratio as the fleece becomes more open. The Navajo Indian sheep, which have very coarse, open fleeces, resembling somewhat that of a goat, rarely if ever are affected with hard scab. While the infection will remain in a flock of such sheep indefinitely if not treated, the lesions seldom become extensive. In the semiarid sheep-ranging sections of the United States it is a well-recognized fact that if scab is to be detected in a flock examination must be made before or at the time of shearing. If the scabby sheep in these sections are shorn and turned out on the ranges, where the sunlight is very bright, the scabs dry up, drop off, and the lesions apparently heal. Evidently the infection is not destroyed, but remains dormant, as the disease will as a rule break out again under certain favorable conditions. After the wool

has grown sufficiently to shade the skin and the fleece becomes wet from rain, the disease usually becomes well marked.

The most important factor in spreading scab infection in the range country is the buck, which is a source of danger too often overlooked. It is the custom in many sections for owners of sheep to put their bucks in a "public buck herd." That is, a number of owners all turn their bucks into one herd and a sheep herder takes charge of this community buck herd and runs it on the open range until within a few weeks of the time when the bucks are to be turned into the ewe flocks. The herd is then split up, each owner taking his bucks home to be fed grain in preparation for the breeding season. These herds usually consist of from 1,200 to 1,500 bucks, representing a large number of owners. Should scab exist in any of the outfits at the time the herd is made up, the entire herd will become infected. Infection may find its way into the buck herd in a number of different ways, and once introduced the disease will be carried into all of the outfits represented, unless the herd is treated prior to disbandment. It is estimated that more than 90 per cent of the outbreaks of scab in the sheep-growing sections of the West can be traced directly to the public buck herds. All such herds should be dipped just prior to the time the animals are to be distributed to the various owners. This is one of the most important points in eradicating scab from the flocks on the open ranges where this custom prevails.

One or more attacks of the disease do not confer immunity, and a flock may become infected any number of times. After a flock has been properly treated and the disease cured by dipping, it may become reinfected, if exposed by contact with infected animals, bedded down on old infectious bed grounds and corrals, driven on trails or roads over which infected sheep have recently passed, turned on to infectious ranges, pastures, or yards where infected sheep have recently been, or in any other manner directly exposed to the infection. As a rule the visible symptoms of reinfection do not appear until after a lapse of 30 days from the date of the last dipping. If conditions are favorable and the sheep are thriving, a much longer period may elapse before they show visible symptoms of disease from exposure to infection after dipping. The dip that is left in the wool after dipping will often serve, for a limited period of time, as a preventive against reinfection. The length of this period of protection varies with the climatic conditions and the kind of dip used. If the sheep are exposed to frequent, heavy rains after dipping, much of the dip will be washed out of the fleece. A dip containing sulphur acts as the best preventive against reinfection. Under average conditions such a dip will probably afford protection for a period of from 30 to 60 days and, under favorable conditions, for a much longer time.

TREATMENT.

The only rational treatment for common scab consists in using some external application which will kill the parasites. Feeding sulphur and salt and various other preparations to sheep will not destroy the parasites and consequently will not effect a cure. Hand dressing, or "spot doctoring" as it is commonly called, consists in soaking the affected parts with a medicated solution of strength sufficient to kill the mites. This acts as a palliative and tends temporarily to check the disease, but will not effect a cure. The only conditions under which hand dressing can be advised are (1) when the disease develops in a few sheep of the flock during severe winter weather or just prior to lambing, in which event the infected sheep should be isolated from the flock and may be given a hand dressing to keep the disease in check until arrangements can be made for dipping the entire flock; (2) all sheep affected with hard scab should be separated from the flock just prior to dipping and the crusts or scabs broken up with a cob or stick and the spots soaked well with dip a little stronger than is used in the bath. It can not be too strongly emphasized that hand dressing, or spot doctoring, will not cure scab; in fact, in many cases it is responsible for spreading the disease, for the reason that the sheepman too often depends on this method to effect a cure. Meantime the disease is spreading throughout his flocks and the premises occupied are becoming infectious. Temporizing methods in dealing with sheep scab are expensive in the long run and should never be used or depended upon.

DIPPING SHEEP.

Dipping consists in immersing the sheep in a medicated solution that will kill the parasites, and is the only practical method known for eradicating the disease from the flock. The usual method is for the sheep to enter one end of a vat filled with dip, through which they swim, and leave the vat at the opposite end. The dip or solution should be used warm in order that it may penetrate the fleece and the hard scabs or crusts. Two dippings 10 to 14 days apart are necessary to effect a cure. The first dipping kills the live mites but does not destroy the eggs. Within 10 days after the first dipping the eggs on the skin at that time will have hatched out, but the new mites will not have reached maturity or laid eggs. The second dipping kills the new mites hatched subsequently to the first dipping.

As a basis of practice it may be stated that one dipping will not cure scab. Sheep in full fleece will retain more of the dip in the wool than freshly shorn sheep or lambs with short wool. If the active principle of the dip used is only slightly volatile and the

sheep have heavy fleeces, one dipping will sometimes effect a cure. The reason for this is that sufficient dip remains in the wool to kill the new crop of mites. One dipping, however, can not be depended upon to cure the disease, and it will fail to do so in the large majority of cases. It will certainly fail unless conditions are just right; consequently all scabby sheep should be given two dippings with an interval of 10 to 14 days between dippings. The entire flock should be dipped regardless of the number showing infection. To pick out the ones showing scab and dip no others will result in failure, as the disease will continue to develop in the undipped portion of the flock.

If the dipping is to be successful it is necessary to give close attention to the details and to see that the work is carefully and

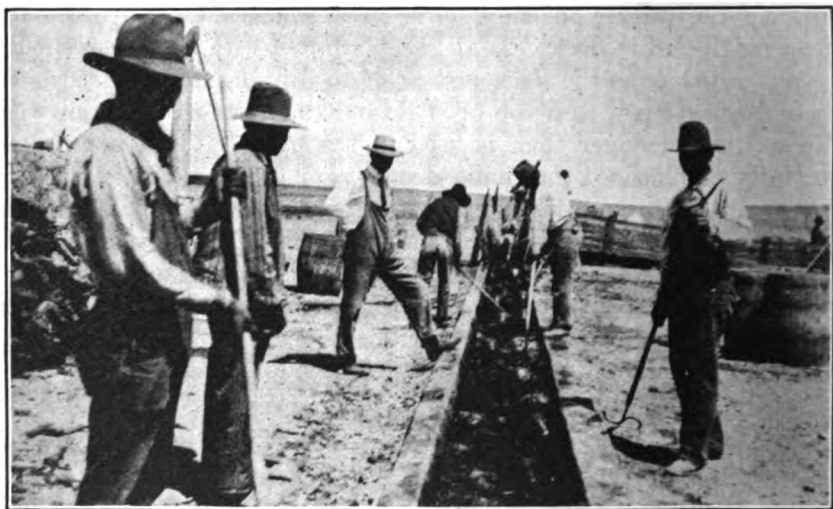


FIG. 11.—Dipping sheep in cement vat, showing entrance.

thoroughly performed. Sheep should not be dipped immediately after shearing; a period of at least 10 days should elapse between shearing and dipping, in order that the shear cuts may heal. It is dangerous to dip sheep in some of the dipping preparations, especially lime-and-sulphur, if there are any fresh wounds on the animals; consequently dogs that bite the sheep should not be allowed in the dipping corrals. The chutes, pens, and dipping vat should be closely examined for nails, broken boards, or any object that may puncture or wound the skin of the sheep. Animals having fresh wounds when dipped in lime-and-sulphur usually develop a condition commonly known as "blood poisoning," and the mortality from this cause is high. It does not occur unless there are fresh wounds on the skin. After the wounds have granulated or healing is well

started there is little or no danger from this cause. Rough handling of the sheep at the time of dipping results in more harm and damage to the flock than is caused by the dip. When sheep are placed in the dipping vat by hand the men handling them should be instructed to do so carefully. They should not be allowed to catch the sheep by the ears; this is sometimes done and has resulted in breaking or bruising the skin, causing the heads to swell after dipping and resulting in considerable death loss.

Ewes and lambs should not be dipped together. The lambs should be "cut out" and dipped separately, and they need not be held in the swim so long as the older sheep. If the ewes and lambs are put into the vat at the same time, the danger of drowning some of the

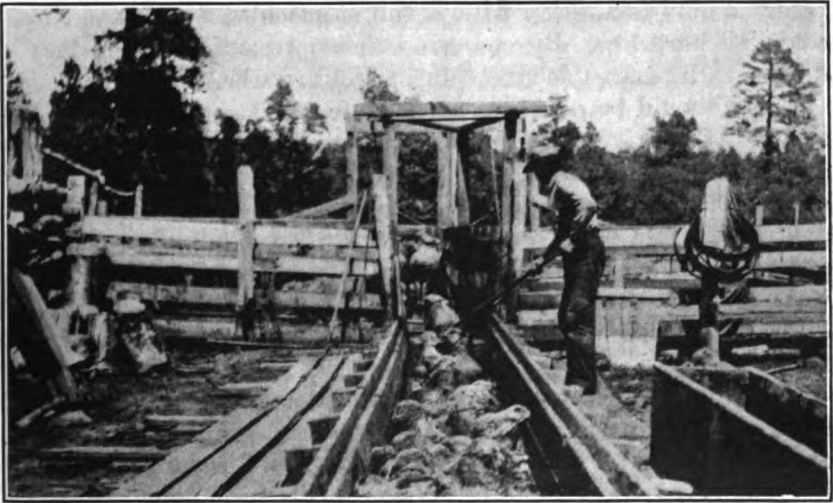


FIG. 12.—Dipping sheep in wooden vat, showing exit.

latter is much greater than when they are dipped separately. It has been stated that the ewe recognizes her lamb more readily when they are dipped together; this, however, is probably not correct. A ewe recognizes her lamb by smell and not by sight, consequently after the flock has been dipped and the ewes and lambs have been turned in together there is considerable commotion for a time, as the ewes fail temporarily to recognize their offspring. However, the members of the flock will adjust matters for themselves, and, as a rule, practically every lamb will be recognized by a mother. It often happens that an undipped sheep will jump out of the pens and get in with those that have been dipped. This should be carefully guarded against and all such sheep dipped before the flock leaves the vat. By looking the dipped sheep over it is easy to

detect any undipped sheep that may have gotten in with the dipped ones.

Prior to bringing the sheep to the vat for dipping they should be watered and fed so as not to be thirsty or hungry at the time of dipping, although they will probably stand the effects of dipping better if not too full of feed and water at the time dipped. If they are watered and fed 3 to 6 hours before dipping, they will probably be in the best condition for the operation. When the weather is cold or stormy, dipping operations should be commenced early in the morning and finished for the day in time to give the last sheep dipped opportunity to dry off before night. During winter weather dipping for the day should be finished by noon so that the flock may have time to dry off and fill up with feed before night, as a sheep with a full stomach will withstand much cold and hardship. By observing these precautions sheep may be dipped with reasonable safety during cold weather.

Bucks should be dipped separately from ewes and lambs. They should not be driven fast and then put into the vat before resting and cooling off. As they succumb very easily in the vat it is necessary to give them careful attention. Hard scab on rams is difficult to cure and they should be held in the swim for 3 to 5 minutes. The hard scabs should be broken up by manipulation so that the dip may penetrate to every part. At the large vats the buck herds are usually dipped first, while the vat is full, so as to afford them more swimming room.

For dipping purposes soft water is better than hard; apparently some of the ready-prepared dips do not mix properly and are not effective with hard water. If hard or "alkali" water must be used it is improved and its effects on scab increased if it is softened or "cut" by adding lye or sal soda, but no more should be added than is required to cut the water. An excess of potash will tend to injure the wool and cause an irritation of the eyes.

DIRECTIONS FOR DIPPING.

The amount of dip in the bath should be sufficient to submerge the sheep completely. The depth of the dipping fluid in the vat should be from 40 to 48 inches, depending on the size of the sheep. The amount of fluid necessary to fill the vat to the required depth should be ascertained before it is prepared. Freshly shorn sheep and short-wooled lambs will carry out on an average from 1 to 2 quarts of dip, depending on the size of the sheep and the length and grade of wool, while full-fleeced, fine-wool sheep will carry out and retain in the fleece as much as 2 gallons. At late fall dipping the average medium-wool sheep will retain in the fleece about 1 gallon of dip. In estimating the amount of dip required, these facts should

be taken into consideration. After computing the amount of dip required to charge the vat, the average amount of dip which each sheep will carry out should be estimated; this should be multiplied by the number of sheep to be dipped and the product so obtained added to the amount required to fill the vat. If the vat and draining pens are watertight, so that no dip is lost through these sources, the total as given above should show the approximate number of gallons of dip required to complete the work.

The temperature of the dip should not be a matter of guesswork, but should be ascertained accurately by using a thermometer. If it is too high the sheep may be injured, and if too low failure to cure will probably result. In field operations, when the dipping is supervised by inspectors, the temperature of the dip is maintained at 100° to 105° F. Practice has demonstrated that the lime-and-sulphur and nicotin

dips should be used at these temperatures. The coal-tar-creosote and cresylic-acid dips should be used at slightly lower temperatures, the maximum for these being 95° F. For use in dipping small lots of farm sheep an ordinary dairy thermometer will answer the purpose. At the large vats where a great many sheep are to be dipped at least two thermometers should be provided as a precaution against breakage and delay. The thermometers used at dipping vats should be tested occasionally by comparison with another thermometer, so as to be sure that they are registering properly. (See figs. 13 and 14.)

After the vat is filled to the required capacity the contents should be well mixed by stirring, in order that the temperature may be uniform throughout. A good method of stirring the dip in large vats is to take a 5-gallon pail or dip container, punch holes near the top, insert a wire for a bail, allow the can to fill and partially sink, then drag it rapidly from one end of the vat to the other, and repeat the process until the temperature is uniform as shown by temperatures taken at several points in the vat. Stirring plungers are useful implements, and, as they are easily made, one or more should be provided at every vat. They are used in a manner similar to the



FIG. 14.—The thermometer used by Bureau of Animal Industry inspectors, in holder whitened from a block of wood.



FIG. 13.—Floating dairy thermometer.

movement of the dasher of an old-fashioned hand churn. The plunger is pushed to the bottom of the vat and raised rapidly, the process being repeated as the operator moves slowly along the vat. The style shown in the cut is the one most commonly used. (See fig. 15.) The dip should be changed as soon as it becomes filthy, regardless of the number of sheep that may have been dipped in it. In emptying the vat the entire contents should be removed, including all sediment and foreign matter. After the liquid portion has been dipped out or drained off the sediment and dirt at the bottom should all be removed and the bottom cleaned by sweeping

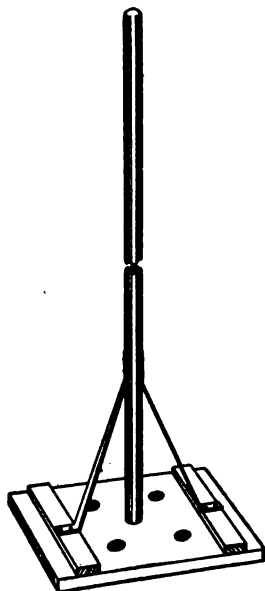


FIG. 15.—Stirring plunger for mixing liquids in the vat.

or scraping with a hoe or spade. After the lime-and-sulphur dip has been mixed to the proper strength for dipping and used in the vat, it should not be used again after it is 10 days old. This is a safe rule to follow with any of the sheep dips, as losses often occur from dipping in old or stale dips.

The time that infected sheep are held in the dip should in no case be less than 2 minutes; if the scab is not advanced, from 2 to 3 minutes in the vat is sufficient. But in well-advanced cases of hard scab on fine-wool sheep, especially bucks, better results are obtained if they are held in the vat from 3 to 5 minutes during the first dipping. If the hard scabs and crusts are broken up and soaked with dip before the sheep are dipped, it is not necessary to hold them in the vat longer than 2 minutes. In all cases in which the scab is advanced it is recommended that the hard scabs be broken and hand

dressed with a solution of the dipping fluid so as to soak the affected parts well. In hand dressing such spots care should be taken not to cause the wound to bleed, as the blood will tend to protect the mites from the effect of the dip. After hand dressing such sheep allow at least 1 hour for the scabs to become soaked before placing the sheep in the vat. The time the sheep are in the vat should not be a matter of guesswork. A watch or a 2-minute sand glass should be used to make certain that the animals remain in the dip a sufficient length of time. Where a large vat is used and the sheep are running fairly well it is possible, after a little practice, to arrive at an average working rule as to how many sheep are to pass through the holding gate each time it is raised.

Drowning sheep in the vat can be avoided by proper care. Men with dipping forks should be stationed along the vat on both sides to attend to the sheep and prevent accidents. When the vat becomes filled with sheep their progress is retarded and the tendency is for each sheep to place its front feet on the back of the sheep in front and thus raise its forequarters out of the dip. The men along the vat should prevent this by keeping the sheep properly arranged in the vat. The dipping forks should be used to keep all of the sheep's body submerged but its head while it is passing through the vat; this can be done by placing the dipping fork over the shoulders of the sheep and gently but firmly pushing it under the dip. The animal will raise its nose so that the neck and part of the head can be submerged without danger of strangling. Old ewes that have been dipped a number of times are sometimes difficult to handle, both in the chutes and in the dip. They will often lie on their sides in the vat, bracing themselves with their feet against one side and their backs against the other. When pushed under they will make efforts to regain this position and may strangle. Sheep that are affected by eating loco weed often drown in the vat unless they are piloted through. When strangling occurs the sheep should be taken from the vat. If it does not get upon its feet, pull the tongue forward, dash cold water over the head and body, and, if necessary, induce artificial respiration. When it has acquired sufficient strength, and if it has not been in the dip long enough, the animal should be returned to the pens and piloted through the vat again.

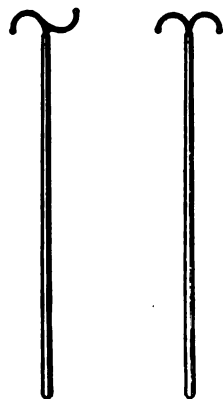


FIG. 16.—Two styles of dipping forks.

DIPPING FORKS.

In using large vats dipping forks are necessary for the efficient handling of the sheep and should be provided as part of the equipment at every plant. There are a number of different styles made, but the two shown in the illustration are the ones commonly used. The one with both hooks turned upward seems to have the preference for the reason that when it is in use either side may be hooked under the neck of the sheep for raising the head in case of strangling. (See fig. 16.) The handles should be strong and from 5 to 6 feet long. The hooks should be made of half-inch round iron and firmly held in the handle by an iron ferrule. These forks can be bought ready-made or may be made by any blacksmith.

EXPENSE OF DIPPING.

The cost of dipping naturally varies in different sections; it also varies in the same section, depending on the number of sheep to be dipped, the location relative to the necessary supplies, and the facilities available for the work. The labor, fuel, and cost of the materials are the three principal items of expense. In the sheep-growing sections of the West the average cost of dipping sheep varies from 2 to 3½ cents per head for each dipping.

CHOOSING A DIP.

There are many dipping preparations on the market. The farmer or sheepman should not be deceived by exaggerated statements made by manufacturers. He should know the nature of the dip he is using and its effects upon the sheep when used in the kind of water which he has available. If a ready-made dip is to be used, one should be selected that will kill the parasites and not cause undue injury to the sheep. Almost any of the better-known ready-prepared dips will prove satisfactory if used according to directions and with pure water. If the dipping plant is not supplied with pure, soft water, a dip should be selected that will work well in the kind of water available. Lime-and-sulphur dip mixes properly and is effective with almost any kind of water. The coal-tar-creosote and cresylic-acid dips apparently do not mix uniformly with some of the hard waters, and they should not be used with such waters.

The dips on the market to-day can be divided into five general groups—those containing arsenic, the cresylic-acid group, coal-tar-creosote dips, nicotin, and lime-and-sulphur. Of these the Bureau of Animal Industry recognizes only two groups for the official dipping of sheep for scabies, namely, lime-and-sulphur and nicotin-and-sulphur.

It has been determined from actual experience over a large field that dips deteriorate by use; that is, after a number of sheep have passed through the vat the active principle of the dip falls below the standard required for effective work. In order to overcome this difficulty and keep the dip up to standard while being used, chemical testing outfits have been designed that can be used at the vat to determine the percentage of the active principle in the dip at any time.¹ In this way the strength can be kept up to the required standard. Before approving a dip for use in the official dipping of sheep, one of the requirements of the Bureau of Animal Industry is that there shall be a practical field test for such dip. Of the five general classes of sheep dips named above, excluding arsenical

¹ See U. S. Department of Agriculture Bulletin 103, A Field Test for Lime-and-Sulphur Dipping Baths, by Robert M. Chapin. Washington, 1915.

dips for other reasons, the lime-and-sulphur and nicotin-and-sulphur are the only ones for which at present we possess a practical field test.

Whatever dip is selected, the sheep grower should not forget the fact that there are two ways of using it. One way is to use it according to directions given; the other way is to attempt to economize time, labor, or money by using it in weaker proportions than advised and by hurrying the sheep through the swim or failing to dip all the sheep in the flock. If the former method is adopted with any of the established dips the treatment should result in a cure. If the latter method is followed failure to effect a permanent cure will result regardless of what kind of dip is used. It is a loss of time and money to dip sheep unless the work is done properly. Desired results can be accomplished only by performing every part of the work thoroughly and in accordance with approved methods.

PREPARATION OF DIPS.

If a ready-made dip is selected it should be prepared and used in accordance with the printed instructions on the label.

THE LIME-AND-SULPHUR DIP.

The lime-and-sulphur dip is made in the proportion of 8 pounds of unslaked lime (or 11 pounds of commercial hydrated lime, not air-slaked) and 24 pounds of flowers of sulphur or sulphur flour to 100 gallons of water. Place the lime in a watertight, shallow box and add sufficient water to form a thin paste. Sift the sulphur into this and mix well until a paste of about the consistency of mortar is formed, adding water as required. Place this lime-and-sulphur paste into 30 gallons of boiling water and boil for at least 2 hours, adding water from time to time to maintain the quantity at 30 gallons, or in that proportion. During the boiling process the mixture in the boiling tank should be stirred well to prevent the paste from settling and caking on the bottom of the tank; the boiling process should be continued until all sulphur disappears from the surface. A large mortar hoe is a good implement with which to stir the boiling mixture. The lime and sulphur should both be weighed; do not trust to measuring them in a pail or guessing at the weight. It sometimes happens that the sulphur is not all "cut" or dissolved; this is especially true if the lime is not of first-class quality. Those who have had considerable experience in the preparation of lime-and-sulphur dip sometimes add small quantities of extra lime if during the cooking they see that the sulphur is not being "cut" properly. It is advisable, however, for the beginner to hold strictly to the formula laid down, as an excess of lime in the dip will tend to

injure the sheep and the wool. After the mixture has been boiled for 2 hours the liquid should be of a chocolate or dark-amber color.

The contents of the boiling tank should be drawn off or dipped out and placed in the settling tank and allowed to stand until all sediment has settled to the bottom and the liquid is clear. The use of some sort of settling tank provided with a bunghole is an absolute necessity, unless the boiler is so arranged that it may be used for both boiling and settling. An ordinary, water-tight barrel will answer very well for a settling tank at small vats. All settling tanks

of every nature should have an outlet at least 4 inches from the bottom in order that the clear liquid may be drawn off without its becoming mixed with any of the sediment. (See fig. 17.) Drawing off the liquid as above indicated has an advantage over dipping it out, for the reason that in the latter case the liquid is stirred more or less and mixed with the sediment. The prime object is to get the clear liquid without any sediment; the latter should under no circumstances be al-

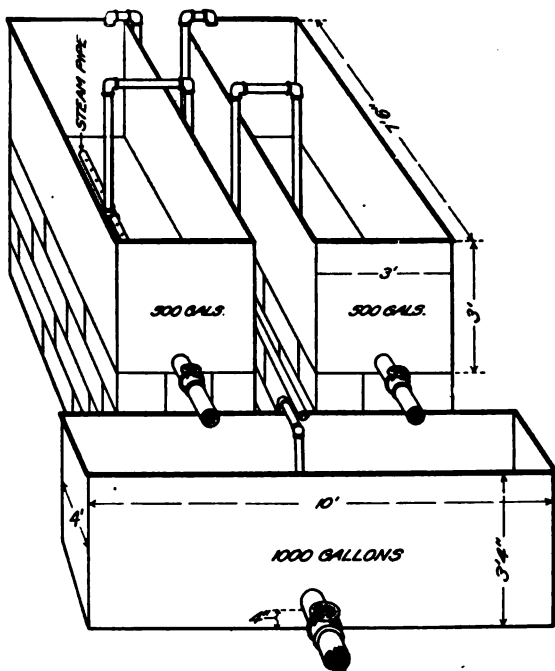


FIG. 17.—Cooking and settling tanks.

lowed in the dipping vat, as it will injure the wool and the eyes of the sheep.

When fully settled draw off the clear liquid into the dipping vat and add warm water sufficient to make a total of 100 gallons of dip. When mixed and cooked as above specified the concentrate is $3\frac{1}{4}$ times the strength required for the dip in the vat, so that to every 30 gallons of such concentrate 70 gallons of warm water should be added to make a dip of the required strength.

In preparing lime-and-sulphur dip in large quantities several hundred gallons of concentrate are often made at one time in a single large cooking tank. The amount made at one boiling is limited only by the facilities at hand. If the boiling tank is of sufficient capacity

enough lime-and-sulphur paste should be cooked at one time to dip the flock. The quantity of mixture in the cooking tank may be varied at will, but the proportions of the various ingredients should not be altered.

THE NICOTIN-AND-SULPHUR DIP.

The nicotin-and-sulphur dip is made with sufficient nicotin solution and flowers of sulphur to give a mixture containing not less than five one-hundredths of 1 per cent (0.05 per cent) nicotin and 2 per cent sulphur. Sufficient nicotin for 96 gallons (about 800 pounds) of dip would therefore be furnished by 1 pound of a 40 per cent solution of nicotin. The formula for this dip would be: Nicotin, four-tenths of a pound; flowers of sulphur, 16 pounds; water 96 gallons.

To calculate how much nicotin solution should be used for 96 gallons of water, divide the quantity of nicotin required in the dip by the proportion of nicotin in the product. For example, suppose the nicotin solution contains 25 per cent nicotin, we have $0.40 \div 0.25 = 1.6$. Therefore in this case it would require 1.6 pounds of nicotin solution for the 96 gallons of dip. No preparation the strength of which is not given on the outside of the package should be used.

In preparing these dips the nicotin solution and sulphur should be mixed together with water before adding them to the water in the dipping vat. The dip should on no account be heated above 110° F. after the nicotin solution is added, as heat is liable to evaporate the nicotin and weaken the dip.

DETERMINING CAPACITIES.

One of the first steps in opening a dipping plant is to ascertain the capacity of the vat and the various tanks. The capacity of the vat is usually obtained in the following manner: In 1 gallon there are 231 cubic inches; multiply the average length by the average width in inches, then the product by the depth; this will give approximately the number of cubic inches of space to be filled with dip. Divide this by 231 and the result will be approximately the number of gallons of dip required to charge the vat.

To obtain the average length, add the length at the bottom to the length at the top (that is, at the line to which the vat is to be filled) and divide this sum by 2. Obtain the average width in the same manner. The depth should be taken at the center of the vat, and should be from bottom to dip line only and not to the top of vat. Likewise in determining the length and width measure only the space to be filled with liquid and not above that line. The capacities of

the various tanks are obtained by a like process. Gauges or rods should be prepared and marked to show the number of gallons at various depths in the vat and tanks.

INJURY FROM DIPPING.

Dipping often results in a slight setback to the sheep. There may be a temporary shrinkage in weight, constitutional disturbances, or both. Usually there are various factors operating to produce these conditions. They may occur with any of the standard dips, but should not always be attributed to the effects of the dip alone. The age and physical condition of the sheep, the method of handling the flock at the vat as well as before and after dipping, the character of the water used, the method of preparing the dip, and various other factors should be given consideration before placing the blame on the dip. Young animals in a thriving condition recuperate very rapidly from any temporary ill effects; while old, weak, or emaciated animals succumb very readily and regain lost weight slowly. Injury caused by dipping is more liable to result from improper methods of dipping and handling than from the direct effects of the dip. Rough handling of the sheep in the corrals and legging pens, dipping the flock immediately after a long, hard drive before they have rested and cooled off, dipping late in the afternoon when the nights are cold, keeping the sheep without feed and water for long periods before and after dipping, using dogs in the corral, and fighting stubborn sheep to get them into the chutes, are some of the contributing causes of injury.

Much of the water in the range country carries various amounts of mineral salts, and is commonly known as "alkali" water. Some of the dips do not seem to mix properly with many of these waters and when they are used a separation apparently occurs, so that part of the sheep get too much of the active principle of the dip with resultant injury or death, while others get less than is required to kill the parasites. The lime-and-sulphur dip is about the only one that is safe to use with very impure water, although the nicotin dips mix well and are effective with most waters. Any of the dips if used too strong will injure the sheep.

In practical operations it is an established fact that lime-and-sulphur and possibly other dips are liable to cause serious injury to sheep if there are any puncture wounds. A condition commonly known as "blood poisoning" is produced, probably caused by micro-organisms entering the tissues and the action of the dip searing or sealing the wound so that the air is excluded and drainage stopped. Pure lime-and-sulphur solution will not injure a sterile wound. The dip does not directly cause the "blood poisoning," but acts only as a contributing cause and can be avoided by allowing wounds to

granulate or heal before dipping. It may be stated that experience has demonstrated that when sheep are properly dipped in accordance with the rules of best practice in any of the approved dips, the loss or damage is practically nil.

The question often arises as to the proper age at which lambs should be dipped to get the best results and cause the least damage. When the average lamb in a flock is 1 month old it is perfectly safe to dip the flock provided the lambs are dodged out and dipped separately. Any slight shrinkage caused at this time will be quickly regained and the lambs will grow and thrive much more rapidly after being freed of the irritation caused by the scab mites. If the work is properly done and the sheep carefully handled, pregnant ewes may with safety be dipped any time up to within one month of lambing.

There has been much controversy and argument concerning the effects that various dips have on the wool, and many experiments have been conducted and observations made over wide areas. The general opinion among the unprejudiced seems to be that the various well-known dips properly prepared and used injure the wool very little, if any. It is necessary to eradicate scab to make wool growing profitable or even possible. Lime-and-sulphur and nicotin-and-sulphur are among the dips that have proved effective and have been generally used as scab eradicators, both in this and in other sheep-growing countries. It is therefore considered that any slight damage they may cause to the wool is more than equaled by their good effects in eradicating scab.

CLEANING AND DISINFECTING PREMISES.

All premises occupied by scabby sheep will become infectious. Tags of wool which often carry mites and eggs are constantly being pulled out. Old bed grounds, corrals, sheds, or any place where infected sheep have been confined or held until the manure has accumulated are especially dangerous. It is probable that bright sunlight kills the mites, but if they can get under manure or anything that affords shade, moisture, and protection the infection may remain for as long as one year. Sheep free from infection should not be allowed on infectious premises. Old bed grounds, corrals, and other places of close confinement should be avoided unless they have been cleaned and disinfected. Ranges, pastures, trails, and grounds around watering places exposed to the sunlight probably do not, as a rule, remain infectious longer than 30 to 60 days. It is well, however, to avoid places over which infected sheep have passed. Such places, as well as old bed grounds on the range, can not be disinfected, or at least it is not practicable to do so, and therefore they

should be avoided. The average sheep herder seems to have a desire to use old bed grounds, and unless means are taken by the owner to prevent it he will continue to bed the flock on old infectious bed grounds after they have been dipped, thus constantly exposing the sheep to reinfection. Corrals, pens, chutes, and sheds can be disinfected, and they should either be cleaned and disinfected or destroyed if they have contained infected sheep. Remove all manure and litter down to a smooth, hard surface and burn the manure and litter so removed or spread on a field and plow under. Spray the entire surface of fences, grounds, and floors, as well as the walls of sheds or buildings, with a disinfectant, such as a coal-tar-creosote or cresylic-acid solution mixed to double the strength recommended for dipping. The work should be well done, otherwise it will not prove successful. All brush corrals on a range where scabby sheep have been should be burned. Corrals of a more permanent nature may be moved to new locations, but the lumber should be disinfected by spraying or passing through the blaze of an open fire before being used.

DIPPING PLANTS.

There are numerous kinds of dipping plants in use, the size and style varying according to the conditions which are to be met and the individual taste of the owner. The farmer who has but a small flock to dip can use a small portable vat as shown in figure 18, turning

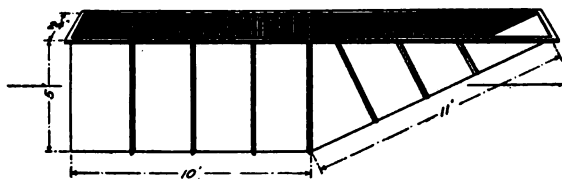


FIG. 18.—Portable galvanized-iron sheep dipping vat.

a part of his barnyard or sheds into catch pens for temporary use, but if he is in the sheep business to stay he will find it advisable to make arrangements of a more

permanent nature. Portable galvanized-iron dipping vats, called "hog vats," can be purchased ready-made and will answer the purpose very well for dipping small lots of farm sheep. A dipping bag is sometimes used for dipping when there are only a few sheep to be dipped at different points in a given section. For this purpose it has the advantage of being easily transported. It is made of heavy canvas, known in the trade as No. 40, and is constructed as follows: Two strips of canvas 8 feet long and 26 inches wide are sewed together to form a bag 48 inches deep and 94 inches in circumference. Seams are triple-sewed, top and corners reinforced with leather strips riveted on. (See fig. 19.) Iron rings held by leather ears are riveted to the upper part of the bag as shown in the cut. The bag is filled with dip, the

sheep's feet tied and the animal is set down in the bag and held the required length of time.

Heating tanks or boilers are necessary, the size varying with the number of sheep to be dipped. An ordinary iron caldron or kettle will answer the purpose for a small number of sheep. A rectangular, galvanized-iron tank with large heating surface is preferable. Such a tank is set on two parallel walls, the walls forming the sides, and the bottom of the tank forming the top of the fire box. An opening large enough for the escape of the smoke should be provided at the end opposite that at which the fire is fed.

When large flocks are to be dipped it is necessary to provide proper facilities for the work and a permanent dipping plant is the only practical solution.

SELECTING A LOCATION.

In selecting a location for a dipping plant the fact that sheep work better upgrade should be given consideration, and if possible the ground used for the receiving corrals and chute should slope up to the end of the vat. The vat itself should be on level ground and preferably extend north and south, with the entrance at the south and the exit at the north, as it has been observed that sheep work better when not facing the sun. If the ground selected has good natural drainage it is a point in favor of the location.



FIG. 19.—Dipping bag, made of No. 40 canvas.

CORRALS AND CHUTES.

One of the important points in constructing a dipping plant is the arrangement of the corrals. Here is where much damage is often caused to the sheep and later attributed to the preparation in which they were dipped. The receiving corral into which the sheep are driven preparatory to dipping, as well as the holding corral into which they go from the draining pens, should each be large enough to hold a full band of sheep, or about 3,000 head. The

receiving corral should be so constructed that there may be the least practicable number of corners or places in which the sheep may become jammed or "piled up."

The nature of the sheep is such that in an effort to get out it will try to go back to the place where it entered the corral; therefore, if the entrance gate is near the vat the herd will tend to crowd toward the vat and thus save considerable work in getting them into the chute or catch pen. The corrals and chutes may be so arranged that a combination legging pen and running chute is provided. Sheep will usually work well in a chute the first time they are dipped at a vat, but with old ewes that have been dipped several times at the same vat it is often necessary to put them into the vat by hand. The location and arrangement of the chutes are sometimes changed from year to year so the sheep may not recognize them so readily. The running chute should be curved to obstruct the view, and the side on which the men work should be tight boarded. The usual height for the sides of the chute is 40 inches. Sheep work well uphill but not down an incline; the chutes and alleys, therefore, should be upgrade to the vat. If necessary elevate the running chute so that it slants upward to the slide board. A small pen should be provided near the entrance to the vat and so arranged that the sheep may see it. This pen, known as a "decoy pen," is filled with sheep to induce the other members of the flock to work toward the vat more readily in their efforts to join those in the pen. The size and arrangement of the corrals will necessarily vary with the topography of the location and the individual ideas or tastes of the owner.

DRAINING PENS.

When a sheep emerges from the vat it carries out a large quantity of dip in the fleece. The major portion of this dip drains out of the fleece very rapidly and it is desirable that it be saved and returned to the vat. Draining pens with water-tight floors sloping toward the vat should therefore be provided. The size will depend upon the size of the plant and the number of sheep to be dipped. The relative size shown in the plans illustrated in figures 20 and 21, may be followed, increasing or decreasing the size of the pens to correspond to the length of the vat. There should be two draining pens, each having an opening into the holding corral. They may be made of lumber or cement and should have catch basins or screening and settling wells into which the dip drains so as to prevent manure and foreign matter from being carried into the vat. Drawings of screening and settling wells will be found in the plan of the cement dipping plant in this bulletin. (See fig. 21.) In constructing draining pens of cement it is advisable to build the outer walls in the same manner

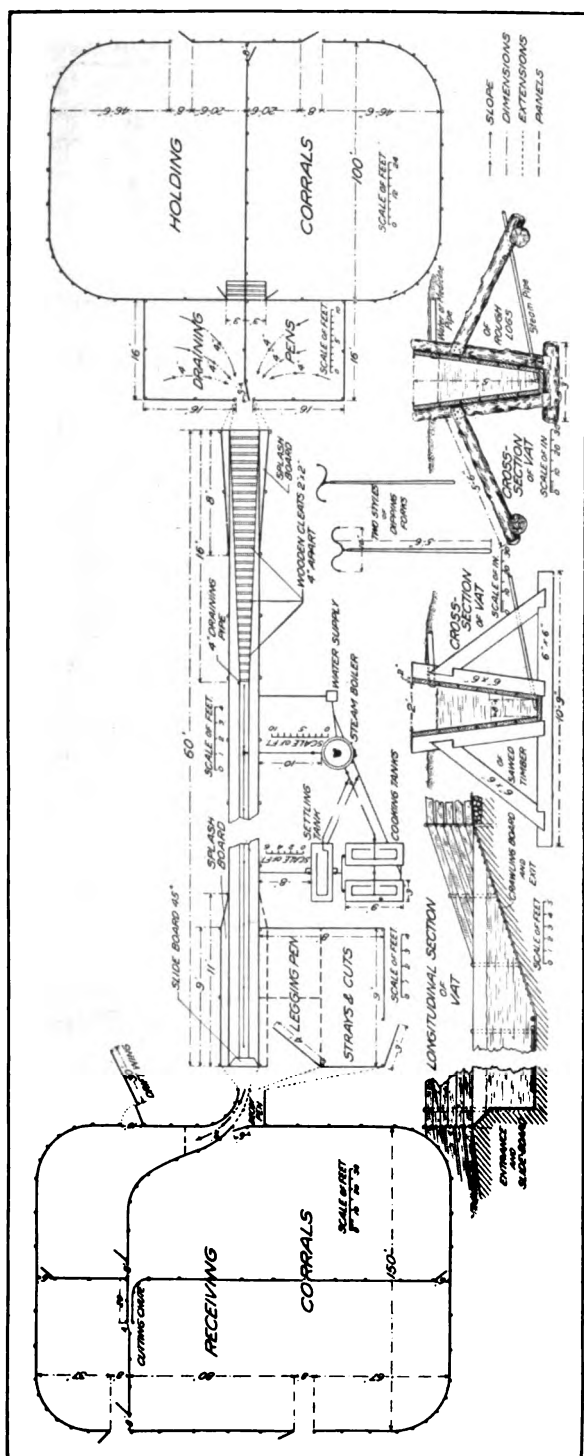


FIG. 20.—Plan of wooden dipping plant.

as the foundations for a house, except that they are to be 6 inches thick. The space inside these walls is then filled with gravel to the required height and the floor laid on it. Cement floors should have rough surfaces to prevent slipping. A coat of "pebble dash" over the cement floors will afford a suitable surface for the sheep to stand on. The floors of draining pens should slope so that the dip will drain away rapidly and not collect in pools from which the animals may drink.

VATS.

The dipping vat may be constructed of either lumber or cement, the cement vat being preferable. The length of the vat may vary from 30 to 100 feet, depending on the number of sheep to be dipped. Public dipping vats, where from 50,000 to 100,000 sheep are dipped each season, should be 100 feet long. The depth should be 5 feet, width at bottom 8 inches and at top 2 feet. Sheep vats are usually so constructed that the top is flush with the top of the ground and there should be no cross pieces to interfere with free action of the sheep or of the men working along the vat. As a matter of individual taste, however, the top of the vat may extend from 9 to 18 inches above the ground. Those of the latter kind afford a better opportunity to handle the sheep and can be operated with less effort. If it is desired that the top of the vat shall be flush with the ground, it should first be built at least 4 inches above the natural surface of the ground and then dirt or gravel may be filled in, thus securing proper drainage along the sides.

Whenever it is possible to do so the gravity method of draining the old dip out of the vat should be adopted, as otherwise it is necessary to pump or dip it out each time the vat is cleaned. The end of the vat having the drain should be slightly lower than the other end so that all the liquid will drain off. The slide board into the vat should be set at an angle of 45 degrees and extend from the floor of the chute to at least 4 inches below the dip line; it should be made of or covered with a smooth-surfaced material, such as planed lumber or sheet metal. The end extending into the dip should be flush with the vertical end of the vat. A space between the slide board and the end of the vat, if large enough for a lamb to lodge in, is a dangerous arrangement. The runway leading out of the vat should not be too steep. The length varies from 8 to 16 feet, the latter being preferable in large vats.

HEATING FACILITIES.

When lime-and-sulphur dip is used it is necessary to provide cooking tanks. The cooking may be done by steam or in open boilers

having a fire box under each. All large plants should have steam boilers of not less than 25 horsepower. The live steam can be piped into the dipping vat and used for maintaining the temperature of the dip and also into the cooking and heating tanks for boiling the dip or heating water. The steam pipes should extend along the floor of the vat at least two-thirds of the length and be provided with openings for the escape of the steam into the dip. The supply pipe from the settling tank should enter the vat above the dip line in order that any leak may easily be detected.

CARE OF PLANT WHEN NOT IN USE.

A dipping plant that does not receive proper care when not in use deteriorates very rapidly. The pressure of the ground against the sides of the vat tends to cause them to bulge inward; this tendency may be counteracted to some extent by keeping the vat full of liquid. Wooden vats which are allowed to stand empty, dry out, and the lumber shrinks so that the vat will leak when refilled. At the close of dipping operations the vat should be left full of liquid and water added from time to time to restore that lost by evaporation.

A week or 10 days prior to beginning dipping operations the entire plant should be overhauled and put in good condition. Before charging a new vat or one which has stood empty for some time, it should be filled with water to ascertain whether it leaks.

CONSTRUCTION OF DIPPING PLANTS.

Plans for the construction of cement and wooden sheep dipping plants are shown in figures 20 and 21. They are not drawn to a uniform scale, consequently, in studying the drawings the scale of each part should be noted. The plants as shown have no superfluous equipment and the arrangements are as simple as is consistent with efficiency. The size of the plant can be increased or decreased as desired. A different corral, chute, and legging pen arrangement are shown with each vat. All parts are interchangeable and are suitable for use with either vat. Cross fences as desired can be added to the corrals. Cutting chutes are shown in both plans, as every large dipping plant should have such a chute equipped with a dodge gate so the lambs may be cut out and dipped separately.

If permanent pipes are used for conducting water and dip to the vat they should be so laid as not to act as an obstacle to the men working along the vat. There should be no obstructions to the path along both sides of the vat. The pipes can be placed under the ground or a portable V-shaped trough can be used for conducting liquids into the vat and laid aside when not in use.

THE WOODEN VAT.

As shown in the plans for the wooden vat, one side of the running chute is made of portable panels so they may be shifted and the space converted into a legging pen. Two styles of framing are shown. In the cedar-growing sections the cedar-post frames are preferable because they do not decay rapidly, while the sawed white-pine timbers do. Where hardwood is used instead of white pine the frame timbers need not be so heavy; 4 by 4 inches is heavy enough for framing in hardwood. The frames are set from $2\frac{1}{2}$ to 4 feet apart, depending on the character of the soil and the material used; $2\frac{1}{2}$ feet apart is a safe rule, as the closer the frames are to each other the less tendency there is for the sides of the vat to bulge in between the frames. Two-inch tongued-and-grooved planks should be used in making the vat, and they should be beveled so all joints and seams may be properly calked with oakum or similar material.

THE CEMENT VAT.

In the plan for the cement plant the corrals and chute are very conveniently arranged. The portable panels can be shifted to form either a running chute or a legging pen. The settling and screening wells shown can also be constructed as a part of any vat by changing the slope of the draining pens so the dip will run into the wells instead of down the runway. In making the forms for a draining well, the groove into which the removable screen is to sit should be provided for, as well as the 4-inch opening into the vat.

The trench for a cement vat should be excavated so the inside dimensions correspond with the outside dimensions of the vat when completed. If the sides of the trench are smooth and reasonably firm, they can be used as the outer wall of the form, but in all cases where the vat is extended above the surface of the ground it is necessary to build forms extending from the surface of the ground to the top of the vat. If the soil is sandy, it will be necessary to build outer forms, in which case the trench should be wide enough to allow for these forms. The drain and other pipes shown in the drawing should be placed in the form and should all be threaded and capped so proper connections may be made. Three pairs of $\frac{1}{2}$ -inch bolts should be embedded in the concrete of the incline for attaching the false floor or runway. This floor is made of 1 by 6 inch boards laid lengthwise with cross cleats, as shown in drawings. Two pairs of bolts also should be embedded for attaching the slide board. Steam pipes should not be molded into the concrete walls, as the vibration of the pipes will crack the cement. They should pass over the top of the vat and down the side in a groove formed

in the wall, so they will not come in contact with the sheep or cause annoyance to the men working along the vat.

The walls should be made 6 inches thick, constructed of concrete mixed in the proportion of 1 part of cement, 2 parts sand, and 4 parts broken stone or gravel. This mixture is slushed into forms properly set, and when it approaches dryness the forms are removed and the inside surface of the vat coated with pure cement mixed to about the consistency of cream and applied with a brush. It is important that this coating be well brushed in so as to fill all cavities and form a smooth surface. Finishing coats of sand and cement applied with a trowel after the forms have been removed are liable to crack and scale off.

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SHEEP SCAB



SHEEP SCAB is a highly contagious skin disease caused by minute insectlike parasites known as mites. Four different varieties of scab mites affect sheep, causing four different kinds of scab known as psoroptic, sarcoptic, chorioptic, and demodectic scab or mange.

Psoroptic or common scab and chorioptic or foot scab can be eradicated by dipping infected sheep twice in warm lime-sulphur or nicotine dip with an interval of from 10 to 14 days between dippings. Sarcoptic scab, also known as head scab or black muzzle, can be cured by repeated dippings in the above-named dips every five or six days for a month or six weeks. No known method is satisfactory for eradicating demodectic scab, which infects the hair follicles of sheep and goats.

Directions for detecting scab, selecting or making dip, dipping sheep, and building dipping vats are given in this bulletin.



SHEEP SCAB

By MARION IMES, *Veterinarian, Zoological Division, Bureau of Animal Industry*

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VARIETIES AND GENERAL CHARACTERISTICS

SCABIES IN SHEEP, commonly known as scab or mange, is a term applied to a group of contagious skin diseases caused by insectlike parasites known as mites, which live on or in the skin. The four species of these parasites which affect sheep are classified in four different genera, as follows: (1), *Psoroptes*; (2), *Sarcoptes*; (3), *Chorioptes*; and (4), *Demodex*.

The mites cause wounds or lesions in the skin of the host animal, and as each kind of mite possesses distinctive habits, the nature and especially the location of the lesions are more or less characteristic. The psoroptic mites, which cause common scab, live in groups or colonies on the surface of the skin and the lesions usually appear on the body. The sarcoptic mites burrow into the skin, making galleries in which they live and reproduce. The lesions appear on the head and face, and occasionally on other parts where there is little or no wool. The chorioptic mites live in groups on the surface of the skin, but usually remain localized on the legs. The demodectic mites are truly microscopic in size, smaller than those mentioned, and in appearance are more like worms than true mites. They live in the hair follicles and glands of the skin and cause hard pimples or nodules.

PSOROPTIC OR COMMON SCAB

Psoroptic or common scab is the most important form of sheep scabies with which the industry in the United States has had to contend. It is a highly contagious skin disease, easily transmitted from one sheep to another by contact, and spreads very rapidly after being introduced into a flock. The disease is not hereditary, but a newborn lamb may become infected from a diseased mother. When allowed to spread, sheep scab causes great financial loss. These losses are caused by (1) a decrease in the quantity of wool produced, (2) loss in weight and general condition from irritation and other effects of the disease which render the animals unthrifty, and (3) the death

of large numbers of infected sheep. Although the disease is highly contagious, insidious in its nature, and severe in its effects, it yields readily to proper treatment and is easily cured. A sheep owner should never allow scab to remain in his flock, as it can be easily eradicated by proper dipping.

THE PARASITE WHICH CAUSES COMMON SCAB

The mites which cause common scab are small white or yellowish parasites known technically as *Psoroptes communis ovis* or *P. ovis*, the mature female measuring about one-fortieth and the male about one-fiftieth of an inch in length. They are visible to the naked eye,

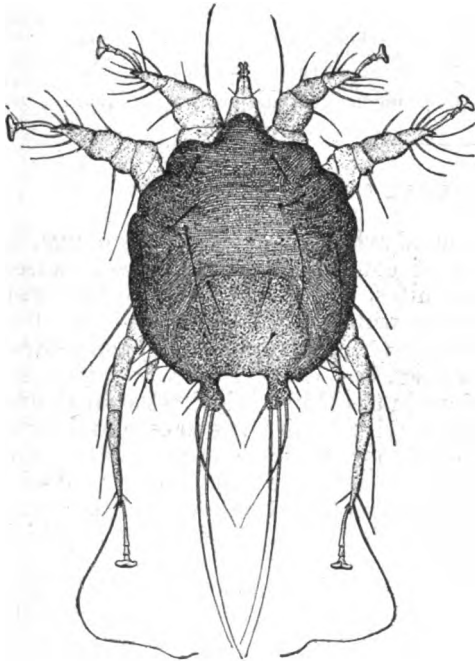


FIG. 1.—Sheep-scab mite (*Psoroptes ovis*). Male. Dorsal view, greatly enlarged. (After Salmon and Stiles, 1898)

especially when they are placed on a dark background. The general form of the body is oval or egg shaped, and the tapering head is longer than broad. These mites when mature have four pairs of legs, all of which extend beyond the margin of the body (figs. 1 and 2).

The entire life cycle is passed on the body of the host animal. Each female may deposit from 15 to 24 eggs, which usually hatch after four to seven days' incubation. The young mites reach maturity, mate, and the females deposit eggs in from 10 to 12 days. These stages in the life history have an important bearing on the interval which should elapse between treatments.

Dipping, if properly done, kills all the mites, but can not be depended on to

destroy all the eggs. Some of the eggs will survive dipping and they may hatch after the first dipping, forming a new generation of mites. To complete the treatment this new generation should be destroyed by a second dipping before they have had time to develop and deposit eggs. As the period of incubation on the host is from 4 to 7 days, and probably never exceeds 10 days, and as the young mites do not begin depositing eggs until they are 10 or 12 days old, it is evident that the interval between the first and second dippings should be from 10 to 12 days. Practical experience has shown that the interval between dippings may be extended safely to a maximum of 14 days; however, the 10 to 12 days' rule should be followed whenever possible.

SYMPTOMS OF COMMON SCAB

When the scab mite finds lodgment on a sheep it pricks the tender skin to obtain food, and in so doing probably introduces a poisonous saliva into the wound. A slight inflammation is caused, made manifest by a reddening of the skin. This stage of the disease is rarely if ever detected by casual observation (fig. 3). As the mites multiply large numbers of small wounds are made in the skin and are followed by intense itching, with formation of papules, inflammation, and exudation of serum. The serum, which oozes to the surface, becomes mixed

with the natural excretions and particles of dirt, and more or less infested with microorganisms. This mass soon hardens into crust or scabs in the wool; these in the early stages are of a yellowish color, but as the disease advances and the scabs thicken they become dark from bloodstains, dirt, and other causes. When the disease begins only a small pimple can be seen, but as the mites multiply they seek the healthier parts around the edges of the diseased area, and thus the lesion or scab is continuously enlarged. The areas of the skin affected become hardened and thickened. This is readily detected by pinching up a portion and comparing it with the surrounding healthy skin. Other conditions resembling scab rarely if ever cause this characteristic, uniform thickening of the skin. When the affected skin is pinched or handled, the sheep as a rule turns its head toward the lesion, thrusts out the tongue, licks the lips, and champs the jaws.

The intense itching causes the sheep to become restless. This irritation is particularly noticeable after the animals have been driven, as itching is more intense when they are heated. They bite and scratch themselves and rub against any available object, including other members of the flock. The natural position of the wool is disturbed by these efforts to obtain relief, and as more or less wool

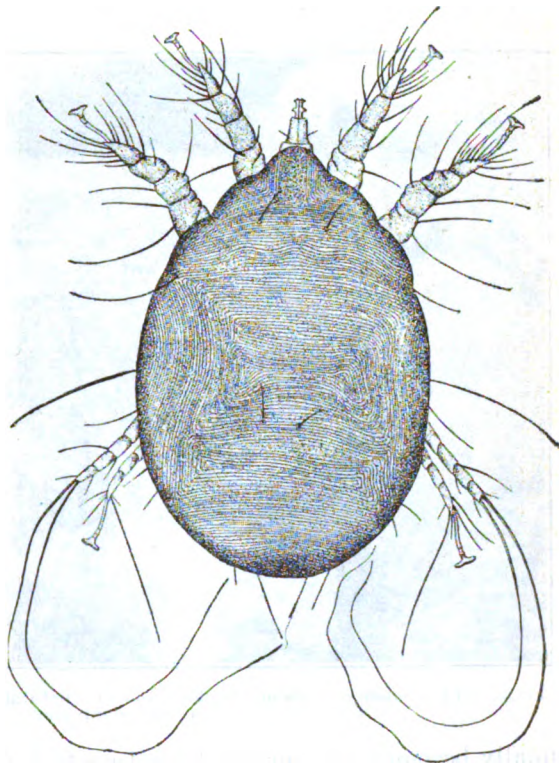


FIG. 2.—Sheep-scab mite (*Psoroptes ovis*). Female. Dorsal view, greatly enlarged. (After Salmon and Stiles, 1898)

is pulled out, the fleece assumes the condition known as "broken" (fig. 4). At first the wool on the affected parts, if within reach of the mouth, is seen to have been chewed and some of it pulled out. The wool on affected parts not within reach of the mouth has a discolored, worn, or ragged appearance, caused by scratching with the hind feet or rubbing against other objects. At this stage the marks of the mouth or feet on the fleece or the disturbed position of the wool may be the only visible symptoms, unless close examination is made of each individual sheep (fig. 5). As the disease advances increasingly large areas become entirely denuded of wool. Scabs fall and are replaced by thicker and more adherent crusts. The skin

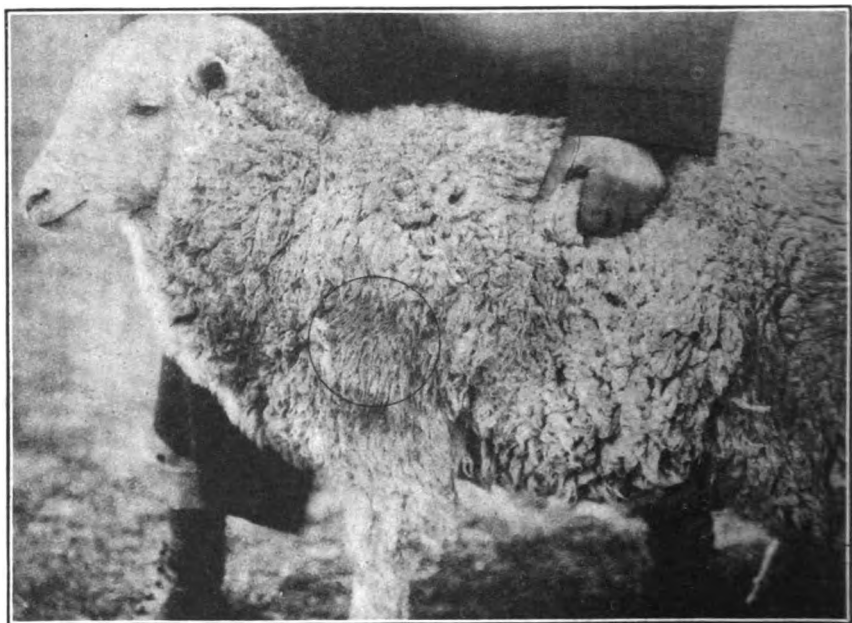


FIG. 3.—First stage of scab on shoulder, showing natural position of wool disturbed by biting and scratching

finally becomes more or less bare, tumefied, is greatly thickened, and may crack and bleed. Unless properly treated many of the animals will die.

DETECTING SCAB IN THE EARLY STAGES

The most certain diagnosis consists in demonstrating the presence of the parasite (*Psoroptes communis ovis*), which alone causes the disease. To obtain specimens of live mites one of two methods is usually employed: (1) Lifting the mite from the surface of the skin with the point of a knife blade, and (2) taking scrapings of wool and epidermis containing the mites and isolating the parasites from the scrapings. To obtain mites with a knife blade good light is necessary. The wool around the affected area is suddenly parted with the forefinger and thumb, and by the aid of a magnifying glass or even with the naked eye the mites can often be seen moving

rapidly away from the light. When they are thus found they can often be picked up on the end of a knife blade.

When scrapings are taken the outer edges of the infected areas should be scraped with a blunt-edged knife. The mass of scrapings is transferred to a smooth, black surface, such as the brim of a black hat or a piece of black paper. To make the mites active the temperature should be approximately the temperature of the body. Spreading the scrapings in the bright, warm sun or near artificial heat will usually cause the mites to become active, and they can be seen as minute, gray, moving bodies against the dark background. They are plainly visible under a low-power hand lens.

When the mites are producing active irritation the surface of the skin in the immediate vicinity of the lesion is greasy and appears

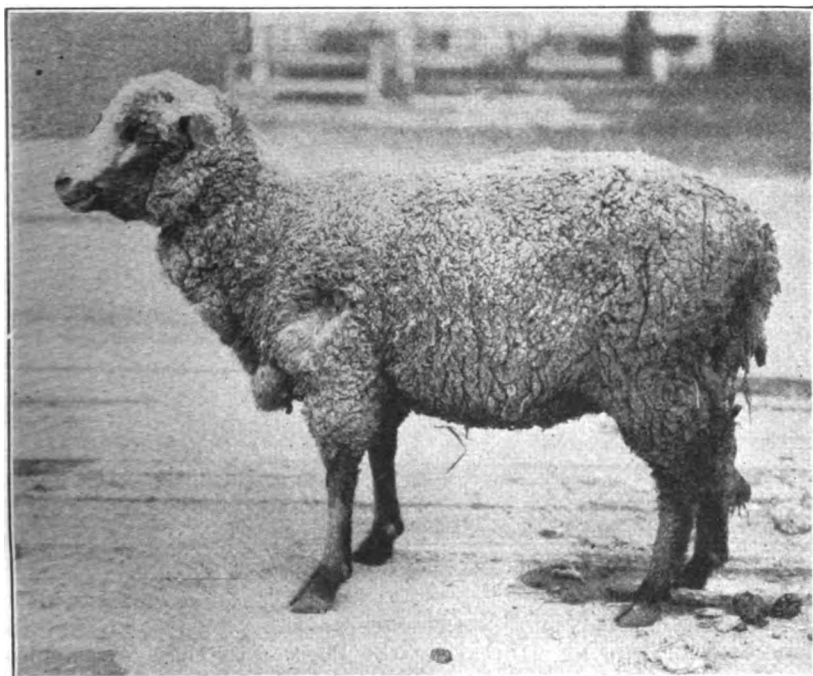


FIG. 4.—First break in fleece, early stages of scab; lesions on shoulder

bright and glistening or white and glossy. Under such conditions the mites are usually present in large numbers and are easily found. On the other hand, if the lesion is dull and dry in appearance it indicates that the mites are inactive at that point and that they will be difficult to find. Usually the latter condition is found in the center of a patch of scab of comparatively long standing or where the mites have been destroyed or rendered dormant. The white, glossy appearance is seen in cases of recent infestation or on the outer edges of old lesions. It is often difficult to find mites during the cold, stormy weather, as they apparently leave the infested area, where the wool is light, and seek shelter where it is heavier.

Any condition which causes the sheep to bite and scratch should be investigated at once and the cause definitely learned. Scab on certain parts of the sheep's body may be overlooked. It is usually found on the back or sides, but may start on any part of the body. Lambs are sometimes infected around the head between the horns and ears, and as these parts are frequently covered with dirt the lesions may not be noticed unless close examination is made. Scab mites are sometimes found in the ear and in the groove beneath the eye, which may explain some cases of fresh outbreaks after treatment, the mites in these places surviving imperfect dipping. On wrinkled breeds, and especially on the bucks of these breeds, scab may be so well concealed in the wrinkles as to render its detection difficult. The breasts and bellies of suspected bucks of all breeds should be closely examined, as these parts are frequently affected. In some cases a con-



FIG. 5.—Characteristic scab lesion in early stages of the disease

siderable area of scab may be present, especially on the back of the sheep, without causing a break in the fleece. In these cases, most often found in tight-wool sheep, the wool will be "raised" from the skin but is held so firmly by the surrounding wool that it may escape detection. Bucks are not so sensitive to the effects of scab as other sheep; consequently they may have scab a long time without showing any breaks in the fleece. In some cases they do not bite or rub the affected parts enough to cause dislodgment of the wool.

Well-advanced cases of hard scab are usually easy to diagnose, but the disease should never be allowed to reach this stage, as it entails heavy loss to the owner and the entire premises may become infectious. The experienced sheep grower realizes that a case of common scab, if neglected and allowed to spread, will materially reduce the profits and often place the balance on the wrong side of the ledger.

CONTAGIOUSNESS OF COMMON SCAB

Each species of domesticated animal has its own peculiar species or variety of psoroptic scab, and common sheep scab is not transmissible to other animals, except goats. It is, however, highly contagious to all classes of sheep, and is transmitted by direct contact with animals or objects that are carriers of the mites. Although it has been accepted as a fact that the mites are unable to propagate except on sheep, it is well known that they may live on goats for a long period and cause characteristic lesions of scab; consequently, goats

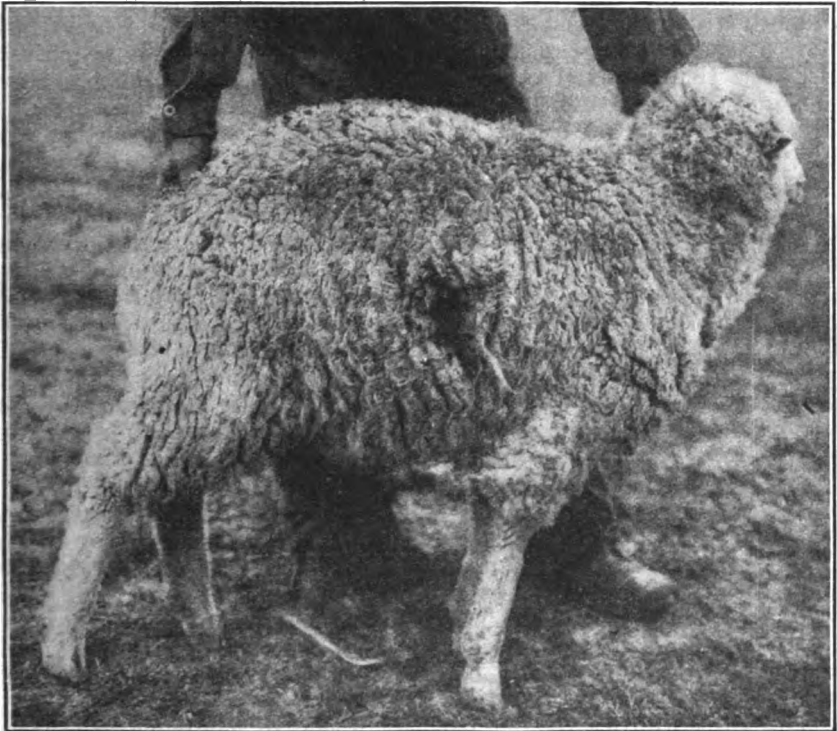


FIG. 6.—A case of scab more advanced than that in Figure 5, showing area denuded of wool

and other animals herded with sheep should be dipped or treated in the same way as the latter.

The most important factor in spreading scab mites is the infected animal, and practically all cases of sheep scab are contracted by contact with infected sheep. In many cases it is difficult to ascertain the source of infection, especially in range flocks, but the two known factors of great importance are "public buck herds" and "strays." The public buck herd should always be closely inspected or dipped just prior to the time the animals are to be distributed to the various owners. Stray sheep which may be infected often find their way into clean flocks, and the herders may not know when or where the "strays" joined the flock.

The possibility of sheep becoming infected from infectious premises should not be overlooked. Various data which have been collected relative to the vitality of the common sheep-scab mite show that when removed from the host the mites commonly live from two to three weeks, and cases of their survival for as long as two months have been recorded. Other things being equal, scab mites will live longer off the host in a cool, moist atmosphere than in a warm, dry one.

The results of a large number of experiments show that usually clean sheep do not contract scab from so-called infectious premises. Occasionally, however, they may become infected from premises or old bed grounds, if such places are used by clean sheep within 30 days of the time they were occupied by scabby sheep. It seems very probable that infected premises which have been vacant for about a month are safe after that time for use by clean sheep. Freshly dipped sheep do not become infected from infectious premises, and

flocks may safely be held on such premises between the first and second dippings. It is good sanitary practice to avoid old bed grounds and uncleaned corrals and premises, but there is practically no danger of scabies infection from such places after 30 days.

Small inclosures used for sheep should be kept clean, and if they have been occupied by scabby sheep the premises should be cleaned and disinfected. Remove all litter and manure, cleaning down to a smooth surface, and spray all exposed surfaces with coal-tar-creosote dip.

The transmissibility of the disease to a flock is not limited to any one season of the year, although during the summer months cases of recent infestation are rarely seen. Scab often remains dormant during hot, dry weather and assumes the appearance of hav-

ing been cured, but usually becomes evident again with the advent of cold, rainy weather.

The susceptibility of the various breeds to common scab varies somewhat in different sections, but as a rule the disease develops more rapidly in fine-wool sheep than in the loose-wool breeds. Fine-wool sheep succumb rapidly to an attack, and treatment to be successful must be carefully applied, because the grease or yolk in the fleece retards the penetration of the dip.

Previous attacks of the disease do not confer immunity, and a flock may become infected any number of times if exposed to the infection. As a rule the visible symptoms of reinfection do not appear until after 30 days or more after the last dipping. The dip that remains in the wool after dipping often serves for a limited time as a preventive against reinfection. A dip containing sulphur may usually be depended on for 60 or more days to afford protection against reinfection if the dip is not washed out of the fleece by rain or otherwise.

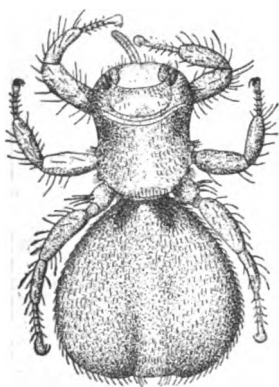


FIG. 7.—Sheep tick (*Molophilus ovinus*). Male. Dorsal view, enlarged. (From Curtice, 1890)

CONDITIONS WHICH MAY BE MISTAKEN FOR COMMON SCAB

Any parasite or condition which causes itching and thus leads the sheep to scratch themselves may temporarily be mistaken for scab, but if it is remembered that scab is caused only by scab mites, and that unless they are present there can be no scab, the diagnosis is rendered more simple.

Common sheep scab may be differentiated from conditions caused by other parasites, such as sheep ticks, common ticks, and lice, by finding the parasite and by the nature of the lesion. If the itching is caused by ticks, an examination will reveal the ticks (fig. 7). They are much larger than the scab mites and are of a dark-brown color. If lice (figs. 8 and 9) cause the sheep to scratch, they can be found on examination, and as they are much larger than a scab mite, they are easily identified. Ticks and lice do not, as a rule, produce pronounced local lesions. They move

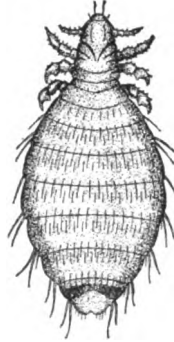


FIG. 8.—Sheep foot louse (*Hematopinus pedalis*). Adult female and egg, enlarged. (From Osborn, 1896)

more or less from place to place on the skin, so that scratching and biting are not repeated persistently in one place, as in the case of scab. It should be remembered, however, that ticks or lice may be present on scabby sheep and that their presence in itself is not enough to warrant the exclusion of scab as a possibility in the diagnosis.

Bearded seeds of grass and weeds, thorns and spines from cacti and various other plants often become lodged in the fleece and prick the skin, setting up an irritation which causes the animal to bite and scratch. In this way wool is pulled out in small tags and the fleece often presents a ragged or broken appearance. The bearded seeds or thorns sometimes penetrate the skin, causing an abscess. On close examination the causative agent can usually be found and removed.



FIG. 9.—Sheep louse (*Trichodectes cephalus*). Adult female, enlarged. (After G. Neumann, 1892)

Eczema, wildfire, summer sores, inflammation of the sebaceous glands, rain rot, shear cuts, sunburn, and the effects of alkali dust on areas denuded of wool may be mistaken for scab by those who are inexperienced.

Eczema is an inflammatory condition of the skin and is usually accompanied with itching and the formation of crusts, and in some cases scabs. It is differentiated from scab by the fact that it does not cause the characteristic thickening of the skin found in common scab, and the mite is not present.

Wildfire, so called, affects sheep mainly in the Northwestern States. It causes the sheep to bite and scratch and the pulling of the wool causes breaks in the fleece. On examination of the infected sheep the skin is found to be red and inflamed, but is soft to the touch. It is not hardened and thickened, as in scab.

A condition commonly known as summer sores exists among sheep in some localities. It appears as an irritating sore on the skin. The sheep bite and scratch the affected parts until the wool is pulled out and the skin becomes raw and bleeding. It is differentiated from scab by the absence of the scab mite, the character of the lesion, and the fact that the skin is not thickened in the characteristic manner.

Inflammation of the sebaceous glands may be mistaken for scab. There is severe itching, the skin is red and sensitive, and there is an excretion of a strong-smelling, yellowish, viscid yolk. The skin does not have the characteristic appearance of scab and the mite is not present.

In rain rot, a condition occurring in rainy weather, an eruption may appear on the skin which may be mistaken for scab. There is, however, no parasite present, itching is absent, and the trouble disappears when dry weather comes.

Shear cuts, sunburn, and the effects of alkali on the skin are conditions found in sheep after shearing. They are easily differentiated from common scab by the character of the lesions and the absence of the scab mites.

TREATMENT FOR COMMON SCAB

The only rational treatment for common scab consists in using some external applications which will kill the parasites. Feeding sulphur and salt and various other preparations to sheep will not destroy the mites, and consequently will not effect a cure. Hand dressing, commonly called "spot doctoring," consists in soaking the affected parts with warm dip. This tends temporarily to check the disease, but will not effect a cure. When dipping can not be done because of cold weather or other reasons, isolation of the visibly affected animals and hand dressing is advisable. All sheep having hard scabs should be separated from the flock just prior to dipping, and the scabs soaked well with warm dip and the crusts or scabs broken up by rubbing with a cob or stick.

Two dippings from 10 to 14 days apart are necessary to cure common scab. The first dipping kills the mites but does not destroy the eggs. The eggs hatch and form a new generation of mites, which must be destroyed by a second dipping before they have had time to lay eggs. The proper interval between the first and second dippings is from 10 to 12 days, but it may be extended to a maximum of 14 days.

The dips commonly used and permitted by the Bureau of Animal Industry for use in official dippings of sheep for scabies are lime-and-sulphur and nicotine solutions. Two dippings 10 to 12 days apart in either one of these dips can usually be depended on to cure cases of common scab if the dips are properly used.

SARCOPTIC OR HEAD SCAB

Sarcoptic scab, commonly known as "head scab" or "black muzzle," is found on sheep in Europe but is not common in the United States. The mite (*Sarcoptes ovis*) which causes the disease burrows into the skin of the head and face where there is little or no wool. The irritation and itching cause the animal to rub and scratch the affected parts, and the hard scabs which are formed are firmly

attached to the underlying skin. This disease may be distinguished from common scab by the nature and location of the lesions and its tendency to remain localized on those parts of the skin which are not covered with wool.

Sarcoptic scab is difficult to eradicate, but the disease can be cured by careful, persistent, and repeated treatments. Thorough soaking of the affected parts with warm lime-and-sulphur dip every five or six days for a month or six weeks will usually be effective.

CHORIOPTIC OR FOOT SCAB

Chorioptic or symbiotic scab, commonly known as "foot scab," is caused by a mite (*Chorioptes ovis*) which closely resembles the common scab mite. The parasites live in groups or colonies on the surface of the skin, usually on the lower parts of the legs and around the feet, but in severe cases they may spread to the inner surface of the thighs and to the udder. The visible lesions usually occur first around the feet and are most pronounced during cold weather, when the flock is housed. The disease is distinguished from common scab by the location of the lesions around the feet and on the limbs, and the failure to spread over the body.

The disease is easily cured, and the treatment recommended for common scab is effective against foot scab. Wading tanks filled with dip may be used during cold weather instead of dipping vats.

DEMODECTIC OR FOLLICULAR SCAB

Demodectic scab, also known as follicular mange, is not common in sheep in the United States, but cases have been reported in milk goats. Since milk goats are becoming widely distributed in this country, veterinarians and breeders should be on the lookout for symptoms of the disease.

The mite (*Demodex folliculorum*) which causes demodectic mange is not visible to the naked eye. They are small, wormlike mites which infest the hair follicles and sebaceous glands, and when present in large numbers they cause swellings or nodules which extend deeply into the skin. The nodules may vary in size from that of a grain of wheat to the size of a walnut. The favorite location in sheep is around the eyelids and in goats around the neck and sides. As the hair over the lesion does not usually fall out the nodules are not readily visible, but they can be detected by passing the hand lightly over the affected area.

The content of the nodules usually is a thick, cheesy mass, which sometimes may be pressed out without lancing the nodule. When the nodules are pressed the discharge may mold or have the appearance of a worm or grub, but on close examination the mass is found to be made up of mites, eggs, and excretions of the skin.

Mature goats appear to be more susceptible than young ones, and the disease spreads slowly by direct contact with infected animals. No reliable method is known for the successful treatment of flocks infected with demodectic mange. Infected animals may be treated by opening all the nodules, removing the contents, and syringing the pockets out with a 2 per cent solution of coal-tar-creosote dip. Some investigators report good results from the use of a few drops

of a saturated solution of carbolic acid in each pocket. After the undissolved acid has settled to the bottom of the container the upper part of the solution may be poured off and used as directed above.

Infected animals should be removed from the flock and treated or destroyed, and as a precautionary measure the flock should be dipped several times in coal-tar-creosote dip.

DIPPING SHEEP

Dipping consists in immersing the sheep in a medicated solution that will kill the parasites, and is the only practical method known for eradicating scabies from the flock. The usual method is for the sheep to enter one end of a vat filled with dip, through which they swim, and leave the vat at the opposite end. The dip or solution should be used warm, in order that it may penetrate the fleece and hard scabs or crusts.

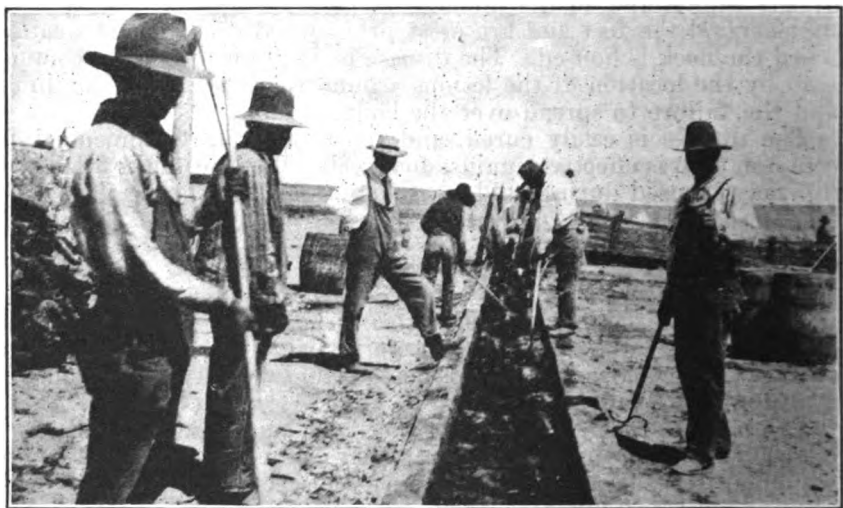


FIG. 10.—Dipping sheep in concrete vat, showing entrance

Two or more dippings are necessary to effect a cure. As a basis of practice it may be stated that one dipping will not cure scab. Sheep in full fleece will retain more of the dip in the wool than freshly shorn sheep or lambs with short wool. Occasionally one dipping will cure cases of common scab and also of foot scab in sheep having heavy fleeces. The reason is that sufficient dip remains in the wool to kill the new crop of mites which hatch after the first dipping. One dipping, however, can not be depended on to cure scab, and it will fail to do so in the large majority of cases. The entire flock should be dipped, regardless of the number showing infection. To pick out the ones showing scab and dip no others will result in failure, as the disease will continue to develop in the undipped portion of the flock.

If the dipping is to be successful it is necessary to give close attention to the details and to see that the work is carefully and thoroughly performed. Sheep should not be dipped immediately

after shearing; a period of at least 10 days should elapse between shearing and dipping, in order that the shear cuts may heal. It is dangerous to dip sheep in some of the dipping preparations, especially lime-and-sulphur, if there are any fresh wounds on the animals; consequently dogs that bite the sheep should not be allowed in the dipping corrals. The chutes, pens, and dipping vat should be closely examined for nails, broken boards, or any object that may puncture or wound the skin of the sheep. Animals having fresh wounds when dipped in lime-and-sulphur usually develop a condition commonly known as "blood poisoning," and the mortality from this cause is high. It does not occur unless there are fresh wounds on the skin. After the wounds have granulated or healing is well started there is little or no danger from this cause. Rough handling of the sheep at the time of dipping results in more harm and damage to the flock than is caused by the dip. When sheep are placed in the

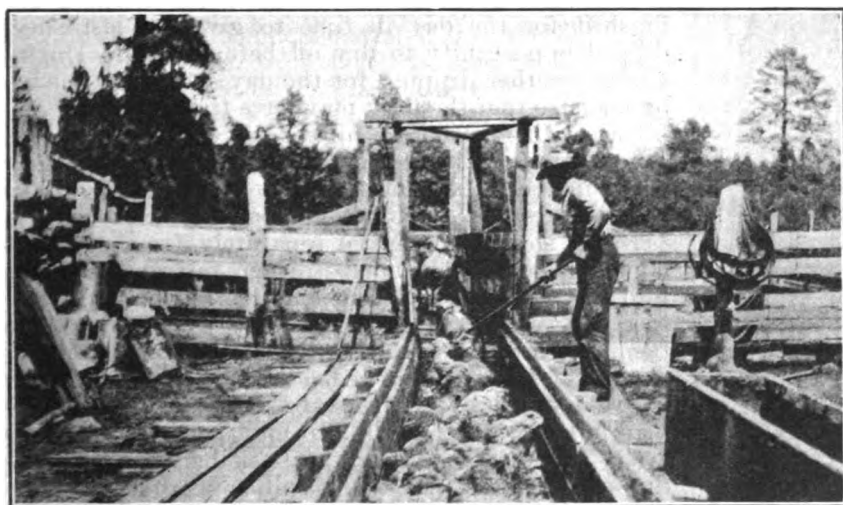


FIG. 11.—Dipping sheep in wooden vat, showing exit

dipping vat by hand the men handling them should be instructed to do so carefully. They should not be allowed to catch the sheep by the ears; this is sometimes done and has resulted in breaking or bruising the skin, causing the heads to swell after dipping and resulting in considerable death loss.

Ewes and lambs should not be dipped together. The lambs should be "cut out" and dipped separately, and they need not be held in the swim so long as the older sheep. If the ewes and lambs are put into the vat at the same time the danger of drowning some of the latter is much greater than when they are dipped separately. It has been stated that the ewe recognizes her lamb more readily when they are dipped together; this however, is probably not correct. A ewe recognizes her lamb by smell and not by sight; consequently after the flock has been dipped and the ewes and lambs have been turned in together there is considerable commotion for a time, as the ewes fail temporarily to recognize their offspring. However,

the members of the flock will adjust matters for themselves, and as a rule practically every lamb will be recognized by its mother. It often happens that an undipped sheep will jump out of the pens and get in with those that have been dipped. This should be carefully guarded against and all such sheep dipped before the flock leaves the vat. By looking the dipped sheep over it is easy to detect any undipped sheep that may have become mixed with the dipped ones.

Prior to bringing the sheep to the vat for dipping they should be watered and fed, so as not to be thirsty or hungry at the time of dipping, although they will probably stand the effects of dipping better if not too full of feed and water when dipped. If they are watered and fed from three to six hours before dipping they will probably be in the best condition for the operation.



FIG. 12.—Floating dairy thermometer

When the weather is cold or stormy dipping operations should be commenced early in the morning and finished for the day in time to give the last sheep dipped opportunity to dry off before night. During winter weather dipping for the day should be finished by noon, so that the flock may have time to dry off and fill up with feed before night, as a sheep with a full stomach will withstand much cold and hardship. By observing these precautions sheep may be dipped with reasonable safety during cold weather.

Bucks should be dipped separately from ewes and lambs. They should not be driven fast and then put into the vat before resting and cooling off. As they succumb very easily in the vat, it is necessary to give them careful attention. Hard scab on rams is difficult to cure, and they should be held in the swim from three to five minutes. The hard scabs should be broken up by manipulation, so that the dip may penetrate to every part. At the large vats the buck herds are usually dipped first, while the vat is full, so as to afford them more swimming room.

For dipping purposes soft water is better than hard; apparently some of the ready-prepared dips do not mix properly and are not effective with hard water. If hard or "alkali" water must be used it is improved and its effects on scab increased if it is softened or "cut" by adding lye or sal soda, but no more should be added than is required to cut the water. An excess of potash tends to injure the wool and cause an irritation of the eyes.

DIRECTIONS FOR DIPPING

The quantity of dip in the bath should be sufficient to submerge the sheep completely. The depth of the dipping fluid in the vat should be from 40 to 48 inches, depending on the size of the sheep. The quantity of fluid necessary to fill the vat to the required depth should be ascertained before it is prepared. Freshly shorn sheep and short-wooled lambs will carry out on an average from 1 to 2 quarts of dip, depending on the size of the sheep and the length and grade of wool, while a full-fleeced, fine-wool sheep will carry out and retain in the fleece as much as two gallons. At late fall dipping the

average medium-wool sheep will retain in the fleece about 1 gallon of dip. In estimating the quantity of dip required these facts should be taken into consideration. After computing the dip required to charge the vat, the average quantity of dip which each sheep will carry out should be estimated; this should be multiplied by the number of sheep to be dipped and the product so obtained added to that required to fill the vat. If the vat and draining pens are watertight, so that no dip is lost through these sources, the total as given above should show the approximate number of gallons of dip required to complete the work.

The temperature of the dip should not be a matter of guesswork, but should be ascertained accurately by using a thermometer. If it is too high the sheep may be injured, and if too low failure to cure will probably result. In field operations, when the dipping is supervised by inspectors, the temperature of the dip is maintained at 100° to 105° F. Practice has demonstrated that the lime-and-sulphur and nicotine dips should be used at these temperatures. The coal-tar-cresosote and cresylic-acid dips should be used at slightly lower temperatures, the maximum being 95° F. For use in dipping small lots of farm sheep an ordinary dairy thermometer will answer the purpose. At the large vats, where a great many sheep are to be dipped, at least two thermometers should be provided as a precaution against breakage and delay. The thermometers used at dipping vats should be tested occasionally by comparison with another thermometer, so as to be sure that they are registering properly (figs. 12 and 13).

After the vat is filled to the required capacity the contents should be well mixed by stirring, in order that the temperature may be uniform throughout. A good method of stirring the dip in large vats is to take a 5-gallon pail or dip container, punch holes near the top, insert a wire for a bail, allow the can to fill and partially sink, then drag it rapidly from one end of the vat to the other, and repeat the process until the temperature is uniform, as shown by temperatures taken at several points in the vat. Stirring plungers are useful implements, and, as they are easily made, one or more should be provided at every vat. They are used in a manner similar to the movement of the dasher of an old-fashioned hand churn. The plunger is pushed to the bottom of the vat and raised rapidly, the process being repeated as the operator moves slowly along the vat. The style shown in Figure 14 is the one most commonly used. The dip should be changed as soon as it becomes filthy, regardless of the number of sheep that may have been dipped in it. In emptying the vat the entire contents should be removed, including all sediment and foreign matter. After the liquid portion has been dipped out or drained off all the sediment and dirt at the bottom should be removed and the bottom cleaned by sweeping or scraping with a hoe or spade. After the lime-and-

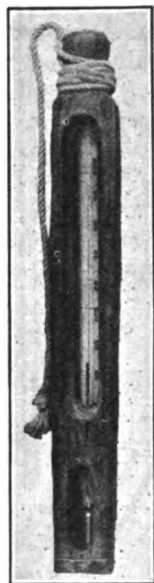


FIG. 13.—Thermometer used by Bureau of Animal Industry inspectors, in holder whittled from a block of wood

sulphur dip has been mixed to the proper strength for dipping and used in the vat, it should not be used again after it is 10 days old. This is a safe rule to follow with any of the sheep dips, as losses often occur from dipping in old or stale dips.

The time that infected sheep are held in the dip should in no case be less than two minutes. If the scab is not advanced, from two to three minutes in the vat is sufficient; but in well-advanced cases of hard scab on fine-wool sheep, especially bucks, better results are obtained if they are held in the vat from three to five minutes during the first dipping. If the hard scabs and crusts are broken up and soaked with dip before the sheep are dipped, it is not necessary to

hold them in the vat longer than two minutes. In all cases in which the scab is advanced it is recommended that the hard scabs be broken and hand dressed with a solution of the dipping fluid, so as to soak the affected parts well. In hand dressing such spots care should be taken not to cause the wound to bleed, as the blood will tend to protect the mites from the effect of the dip. After hand dressing such sheep allow at least one hour for the scabs to become soaked before placing the sheep in the vat. The time the sheep are in the vat should not be a matter of guesswork. A watch or a two-minute sand glass should be used to make certain that the animals remain in the dip for a sufficient length of time. Where a large vat is used and the sheep are running fairly well it is possible, after a little practice, to arrive at an average working rule as to how many sheep are to pass through the holding gate each time it is raised.

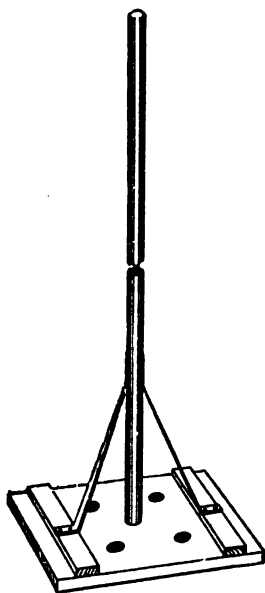


FIG. 14.—Stirring plunger for mixing liquids in the vat

Drowning sheep in the vat can be avoided by proper care. Men with dipping forks should be stationed along the vat on both sides to attend to the sheep and prevent accidents. When the vat becomes filled with sheep their progress is retarded, and the tendency is for each sheep to place its front feet on the back of the sheep in front and thus raise its fore quarters out of the dip. The men along the vat should prevent this by keeping the sheep properly arranged in the vat. The dipping forks should be used to keep all of the sheep's body submerged but its head while it is passing through the vat. This can be done by placing the dipping fork over the shoulders of the sheep and gently but firmly pushing it under the dip. The animal will raise its nose so that the neck and part of the head can be submerged without danger of strangling. Old ewes that have been dipped a number of times are sometimes difficult to handle, both in the chutes and in the dip. They will often lie on their sides in the vat, bracing themselves with their feet against one side and their backs against the other. When pushed under they will make efforts to regain this position and may

strangle. Sheep that are affected by eating loco weed often drown in the vat unless they are piloted through. When strangling occurs the sheep should be taken from the vat. If it does not get upon its feet, pull the tongue forward, dash cold water over the head and body, and, if necessary, induce artificial respiration. When it has acquired sufficient strength, and if it has not been in the dip long enough, the animal should be returned to the pens and piloted through the vat again.

DIPPING FORKS

In using large vats dipping forks are necessary for the efficient handling of the sheep and should be provided as part of the equipment at every plant. A number of different styles are made, but the two shown in the illustration are the ones commonly used. The one with both hooks turned upward seems to have the preference, for the reason that when it is in use either side may be hooked under the neck of the sheep for raising the head in case of strangling (fig. 15). The handles should be strong and from 5 to 6 feet long. The hooks should be made of half-inch round iron and firmly held in the handle by an iron ferrule. These forks can be bought ready made or may be made by any blacksmith.

CHOOSING A DIP

There are many dipping preparations on the market. The farmer or sheepman should not be deceived by exaggerated statements made by manufacturers. He should know the nature of the dip he is using and its effects on the sheep when used in the kind of water which he has available. If a ready-made dip is to be used, one should be selected that will kill the parasites and not cause undue injury to the sheep. Almost any of the better-known, ready-prepared dips will be satisfactory if used according to directions and with pure water. If the dipping plant is not supplied with pure, soft water, a dip should be selected that will work well in the kind of water available. Lime-and-sulphur dip mixes properly and is effective with almost any kind of water. The coal-tar-creosote and cresylic-acid dips apparently do not mix uniformly with some of the hard waters, and they should not be used with such waters.

The dips on the market to-day can be divided into five general groups—those containing arsenic, the cresylic-acid group, coal-tar-creosote dips, nicotine-and-sulphur, and lime-and-sulphur. Of these the Bureau of Animal Industry recognizes only two groups for the official dipping of sheep for scabies, namely, lime-and-sulphur and nicotine-and-sulphur.

It has been determined from actual experience over a large field that dips deteriorate by use; that is, after a number of sheep have passed through the vat the active principle of the dip falls below the standard required for effective work. In order to overcome this

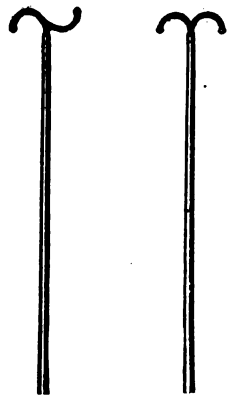


Fig. 15.—Two styles of dipping forks

difficulty and keep the dip up to standard while being used, chemical testing outfits have been designed that can be used at the vat to determine the percentage of the active principle in the dip at any time.¹ In this way the strength can be kept up to the required standard. Before approving a dip for use in the official dipping of sheep, one of the requirements of the Bureau of Animal Industry is that there shall be a practical field test for such dip. Of the five general classes of sheep dips named above, excluding arsenical dips for other reasons, the lime-and-sulphur and nicotine-and-sulphur are the only ones for which at present there is a practical field test.

Whatever dip is selected, the sheep grower should not forget the fact that there are two ways of using it. One way is to use it according to directions given; the other way is to attempt to economize time, labor, or money by using it in weaker proportions than advised and by hurrying the sheep through the swim or failing to dip all the sheep in the flock. If the former method is adopted with any of the established dips the treatment should result in a cure. If the latter method is followed failure to effect a permanent cure will result regardless of what kind of dip is used. It is a loss of time and money to dip sheep unless the work is done properly. Desired results can be accomplished only by performing every part of the work thoroughly and in accordance with approved methods.

DIPS FOR SCAB

READY-MADE PRODUCTS

Lime-sulphur and nicotine are the two dips commonly used in the United States for dipping sheep infested with scabies. The nicotine dips are sold under various trade names, and the percentage of nicotine in the product, as well as specific instructions for diluting the dip, should be given on the label of the container.

Proprietary brands of liquid lime-and-sulphur may be purchased, and many of them are equal to or even better than the homemade product. Manufacturers have also placed on the market a product commonly known as dry lime-sulphur, made by evaporating in a vacuum or in the presence of an inert gas, concentrated lime-sulphur solution to which a little cane sugar has been added to act as a stabilizing agent. The insecticidal constituents of dry lime-sulphur are readily soluble in hot water, and it is extensively used as a dip for animals and as an insecticide for plants. All ready-prepared dips should be diluted and used in accordance with instructions printed on the label of the container.

HOMEMADE LIME-AND-SULPHUR DIP

The lime-and-sulphur dip is made in the proportion of 8 pounds of unslaked lime (or 11 pounds of commercial hydrated lime, not air-slaked) and 24 pounds of flowers of sulphur to 100 gallons of water. Place the lime in a water-tight shallow box and add water enough to form a thin paste. Sift the sulphur into it and mix well until a paste of about the consistence of mortar is formed, adding

¹ CHAPIN, ROBERT M. A FIELD TEST FOR LIME-AND-SULPHUR DIPPING BATHS. U. S. Dept. Agr. Bul. 163. 1915.

water as required. Place this lime-and-sulphur paste in 30 gallons of boiling water and boil for at least two hours, adding water from time to time to maintain the quantity at 30 gallons, or in that proportion. During the boiling process the mixture in the boiling tank should be stirred well to prevent the paste from settling and caking on the bottom of the tank; the boiling process should be continued until all sulphur disappears from the surface. A large mortar hoe is a good implement with which to stir the boiling mixture. Both the lime and sulphur should be weighed; do not trust to measuring them in a pail or guessing at the weight. It sometimes happens that the sulphur is not all "cut" or dissolved; this is especially true if the lime is not of first-class quality. Those who have had considerable experience in the preparation of lime-and-sulphur dip sometimes add small quantities of extra lime if during the cooking they see that the sulphur is not being "cut" properly. It is advisable, however, for the beginner to hold strictly to the formula laid down, as an excess of lime in the dip will tend to injure the sheep and the wool. After the mixture has been boiled for two hours the liquid should be of a chocolate or dark-amber color.

The contents of the boiling tank should be drawn off or dipped out and placed in the settling tank, and allowed to stand until all sediment has settled to the bottom and the liquid is clear. The use of some sort of settling tank provided with a bung-hole is necessary, unless the boiler is so arranged that it may be used for both boiling and settling. An ordinary water-tight barrel will answer very well for a settling tank at small vats. All settling tanks of every nature should have an outlet at least 4 inches from the bottom, in order that the clear liquid may be drawn off without its becoming mixed with any of the sediment (fig. 16). Drawing off the liquid as indicated above has an advantage over dipping it out, for the reason that in the latter case the liquid is stirred more or less and mixed with the sediment.

The prime object is to get the clear liquid without any sediment; the latter should under no circumstances be allowed in the dipping vat, as it will injure the wool and the eyes of the sheep.

When fully settled draw off the clear liquid into the dipping vat and add warm water sufficient to make a total of 100 gallons of dip. When mixed and cooked as specified above the concentrate is three and one-third times the strength required for the dip in the vat, so that to every 30 gallons of such concentrate 70 gallons of warm water should be added to make a dip of the required strength.

In preparing lime-and-sulphur dip in large quantities several hundred gallons of concentrate are often made at one time in a single large cooking tank. The quantity made at one boiling is limited only by the facilities at hand. If the boiling tank is of sufficient capacity, enough lime-and-sulphur paste should be cooked at one time to dip the flock. The quantity of mixture in the cooking tank may be varied at will, but the proportions of the various ingredients should not be altered.

THE NICOTINE-AND-SULPHUR DIP

The nicotine-and-sulphur dip is made with sufficient nicotine solution and flowers of sulphur to give a mixture containing not less than

five one-hundredths of 1 per cent (0.05 per cent) nicotine and 2 per cent sulphur. Sufficient nicotine for 96 gallons (about 800 pounds) of dip would therefore be furnished by 1 pound of a 40 per cent solution of nicotine. The formula for this dip would be: Nicotine 0.4 pound; flowers of sulphur, 16 pounds; water, 96 gallons.

To calculate how much nicotine solution should be used for 96 gallons of water, divide the quantity of nicotine required in the dip by the proportion of nicotine in the product. For example, suppose the nicotine solution contains 25 per cent nicotine, we have $0.4 \div 0.25 = 1.6$. Therefore in this case it would require 1.6 pounds of nicotine solution for the 96 gallons of dip. No preparation the strength of which is not given on the outside of the package should be used.

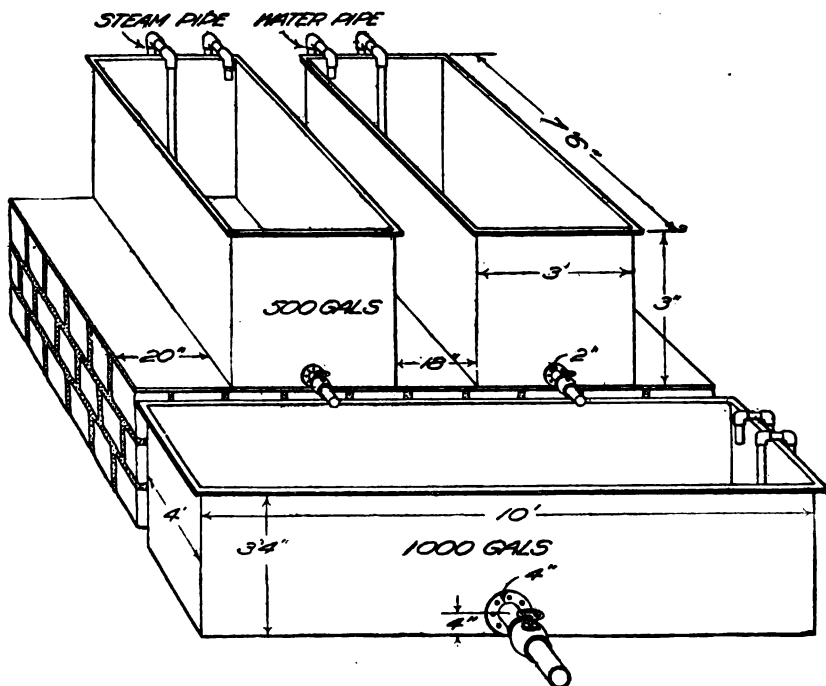


FIG. 16.—Cooking and settling tanks

In preparing these dips the nicotine solution and sulphur should be mixed together with water before adding them to the water in the dipping vat. The dip should on no account be heated above 110° F. after the nicotine solution is added, as heat is liable to evaporate the nicotine and weaken the dip.

DETERMINING CAPACITIES

One of the first steps in opening a dipping plant is to ascertain the capacity of the vat and the various tanks. The capacity of the vat is usually obtained in the following manner: In 1 gallon there are 231 cubic inches. Multiply the average length by the average width in inches, then the product by the depth; this will give ap-

proximately the number of cubic inches of space to be filled with dip. Divide this by 231 and the result will be approximately the number of gallons of dip required to charge the vat.

To obtain the average length, add the length at the bottom to the length at the top (that is, at the line to which the vat is to be filled) and divide this sum by 2. Obtain the average width in the same manner. The depth should be taken at the center of the vat, and should be from bottom to dip line only and not to the top of vat. Likewise in determining the length and width measure only the space to be filled with liquid, and not above that line. The capacities of the various tanks are obtained by like process. Gauges or rods should be prepared and marked to show the number of gallons at various depths in the vat and tanks.

INJURY FROM DIPPING

Dipping often results in a slight setback to the sheep. There may be a temporary shrinkage in weight, constitutional disturbances, or both. Usually there are various factors operating to produce these conditions. They may occur with any of the standard dips, but should not always be attributed to the effects of the dip alone. The age and physical condition of the sheep, the method of handling the flock at the vat as well as before and after dipping, the character of the water used, the method of preparing the dip, and various other factors should be given consideration before placing the blame on the dip. Young animals in a thriving condition recuperate very rapidly from any temporary ill effects, but old, weak, or emaciated animals succumb very readily and regain lost weight slowly. Injury caused by dipping is more liable to result from improper methods of dipping and handling than from the direct effects of the dip. Rough handling of the sheep in the corrals and legging pens, dipping the flock immediately after a long, hard drive before they have rested and cooled off, dipping late in the afternoon when the nights are cold, keeping the sheep without feed and water for long periods before and after dipping, using dogs in the corral, and fighting stubborn sheep to get them into the chutes, are some of the contributing causes of injury.

Much of the water in the range country carries various quantities of mineral salts, and is commonly known as "alkali" water. Some of the dips do not seem to mix properly with many of these waters, and when they are used a separation apparently occurs, so that part of the sheep get too much of the active principle of the dip with resultant injury or death, while others get less than is required to kill the parasites. The lime-and-sulphur dip is about the only one that is safe to use with very impure water, although the nicotine dips mix well and are effective with most waters. Any of the dips if used too strong will injure the sheep.

In practical operations it is an established fact that lime-and-sulphur and possibly other dips are liable to cause serious injury to sheep if there are any puncture wounds. A condition commonly known as "blood poisoning" is produced, probably caused by micro-organisms entering the tissues and the action of the dip searing or sealing the wound so that the air is excluded and drainage stopped.

Pure lime-and-sulphur solution will not injure a sterile wound. The dip does not directly cause the "blood poisoning," but acts only as a contributing cause, and can be avoided by allowing wounds to granulate or heal before dipping. It may be stated that experience has demonstrated that when sheep are properly dipped in accordance with the rules of best practice in any of the approved dips the loss or damage is practically nil.

The question often arises as to the proper age at which lambs should be dipped to get the best results and cause the least damage. When the average lamb in a flock is 1 month old it is perfectly safe to dip the flock provided the lambs are dodged out and dipped separately. Any slight shrinkage caused at this time will be quickly regained, and the lambs will grow and thrive much more rapidly after being freed of the irritation caused by the scab mites. If the work is properly done and the sheep carefully handled pregnant ewes may with safety be dipped any time up to within one month of lambing.

There has been much controversy and argument concerning the effects that various dips have on the wool, and many experiments have been conducted and observations made over wide areas. The general opinion among the unprejudiced seems to be that the various well-

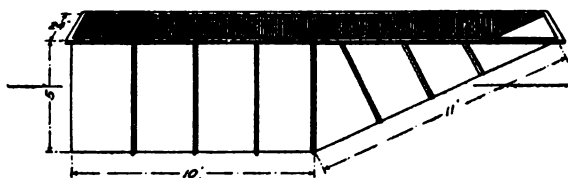


FIG. 17.—Portable galvanized-iron sheep-dipping vat

sulphur and nicotine-and-sulphur are among the dips that have been effective and have been generally used as scab eradicators, both in this and in other sheep-growing countries. It is therefore considered that any slight damage they may cause to the wool is more than equaled by their good effects in eradicating scab.

known dips properly prepared and used injure the wool very little, if any. It is necessary to eradicate scab to make woolgrowing profitable, or even possible. Lime-and-

DIPPING VATS AND PLANTS

There are numerous kinds of dipping plants in use, the size and style varying according to the conditions which are to be met and the individual taste of the owner. The farmer who has but a small flock to dip can use a small portable vat as shown in Figure 17, turning a part of his barnyard or sheds into catch pens for temporary use, but if he is in the sheep business to stay he will find it advisable to make arrangements of a more permanent nature. Portable galvanized-iron dipping vats, called "hog vats," can be purchased ready-made and will answer the purpose very well for dipping small lots of farm sheep. A dipping bag is sometimes used for dipping when there are only a few sheep to be dipped at different points in a given section. For this purpose it has the advantage of being easily transported. It is made of heavy canvas, known in the trade as No. 40, and is constructed as follows: Two strips of canvas 8 feet long and 26 inches wide are sewed together to form a bag 48 inches

deep and 94 inches in circumference. Seams are triple-sewed, top and corners reinforced with leather strips riveted on (fig. 18). Iron rings held by leather ears are riveted to the upper part of the bag as shown in the cut. The bag is filled with dip, the sheep's feet tied, and the animal is set down in the bag and held the required length of time.

Heating tanks or boilers are necessary, the size varying with the number of sheep to be dipped. An ordinary iron caldron or kettle will answer the purpose for a small number of sheep. A rectangular galvanized-iron tank with large heating surface is preferable. Such a tank is set on two parallel walls, the walls forming the sides, and the bottom of the tank forming the top of the fire box. An opening large enough for the escape of the smoke should be provided at the end opposite that at which the fire is fed.

When large flocks are to be dipped it is necessary to provide proper facilities for the work, and a permanent dipping plant is the only practical solution.

SELECTING A LOCATION

In selecting a location for a dipping plant the fact that sheep work better upgrate should be given consideration, and if possible the ground used for the receiving corrals and chute should slope up to the end of the vat. The vat itself should be on level ground and preferably extend north and south, with the entrance at the south and the exit at the north, as it has been observed that sheep work better when not facing the sun. If the ground selected has good natural drainage it is a point in favor of the location.

CORRALS AND CHUTES

One of the important points in constructing a dipping plant is the arrangement of the corrals. Here is where much damage is often caused to the sheep and later attributed to the preparation in which they were dipped. The receiving corral into which the sheep are driven preparatory to dipping, as well as the holding corral into which they go from the draining pens, should each be large enough to hold a full band of sheep, or about 3,000 head. The receiving corral should be so constructed that there may be the least practical number of corners or places in which the sheep may become jammed or "piled up."



FIG. 18.—Dipping bag, made of No. 40 canvas

The nature of the sheep is such that in an effort to get out it will try to go back to the place where it entered the corral; therefore, if the entrance gate is near the vat the herd will tend to crowd toward the vat and thus save considerable work in getting them into the chute or catch pen. The corrals and chutes may be so arranged that a combination legging pen and running chute is provided. Sheep will usually work well in a chute the first time they are dipped at a vat, but with old ewes that have been dipped several times at the same vat it is often necessary to put them into the vat by hand. The location and arrangement of the chutes are sometimes changed from year to year so the sheep may not recognize them so readily. The running chute should be curved to obstruct the view, and the side on which the men work should be tight boarded. The usual height for the sides of the chute is 40 inches. Sheep work well uphill, but not down an incline; the chutes and alleys, therefore, should be up-grade to the vat. If necessary, elevate the running chute so that it slants upward to the slide board. A small pen should be provided near the entrance to the vat and so arranged that the sheep may see it. This pen, known as a "decoy pen," is filled with sheep to induce the other members of the flock to work toward the vat more readily in their efforts to join those in the pen. The size and arrangement of the corrals will necessarily vary with the topography of the location and the individual ideas or tastes of the owner.

DRAINING PENS

When a sheep emerges from the vat it carries out a large quantity of dip in the fleece. The major portion of this dip drains out of the fleece very rapidly, and it is desirable that it be saved and returned to the vat. Draining pens with water-tight floors sloping toward the vat should therefore be provided. The size will depend on the size of the plant and the number of sheep to be dipped. The relative size shown in the plans illustrated in Figures 19 and 20 may be followed, increasing or decreasing the size of the pens to correspond to the length of the vat. There should be two draining pens, each having an opening into the holding corral. They may be made of lumber or concrete, and should have catch basins or screening and settling wells into which the dip drains so as to prevent manure and foreign matter from being carried into the vat. Drawings of screening and settling wells will be found in the plan of the cement dipping plant in this bulletin (fig. 20). In constructing drainage pens of concrete it is advisable to build the outer walls in the same manner as the foundations for a house, except that they are to be six inches thick. The space inside these walls is then filled with gravel to the required height and the floor laid on it. Concrete floors should have rough surfaces to prevent slipping. A coat of "pebble dash" over the concrete floors will afford a suitable surface for the sheep to stand on. The floors of draining pens should slope so that the dip will drain away rapidly and not collect in pools from which the animals may drink.

VATS

The dipping vat may be constructed of either lumber or concrete, the concrete vat being preferable. The length of the vat may vary



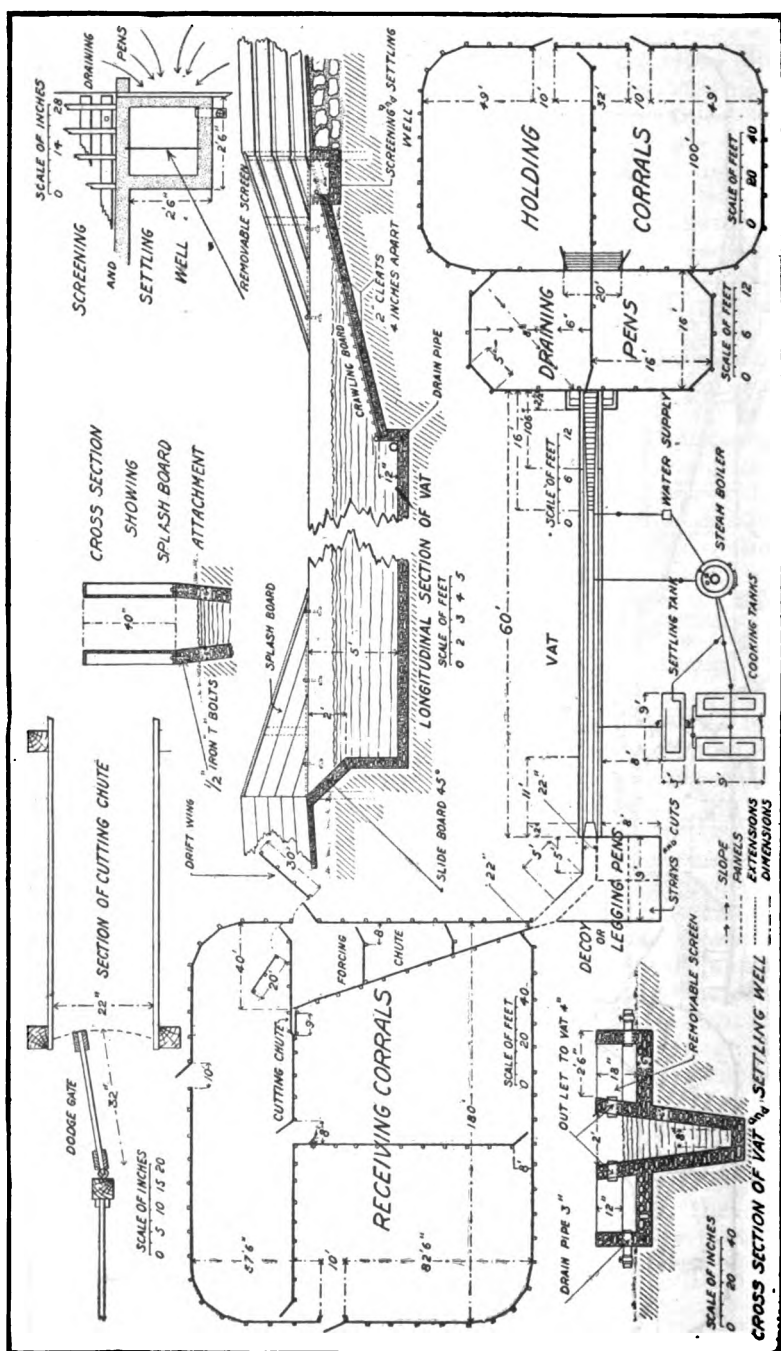


Fig. 20.—Plan of sheep-dipping plant; concrete vat

from 30 to 100 feet, depending on the number of sheep to be dipped. Public dipping vats, where from 50,000 to 100,000 sheep are dipped each season, should be 100 feet long. The depth should be 5 feet, width at bottom 8 inches and at top 2 feet. Sheep vats are usually so constructed that the top is flush with the top of the ground, and there should be no crosspieces to interfere with free action of the sheep or of the men working along the vat. As a matter of individual taste, however, the top of the vat may extend from 9 to 18 inches above the ground. Those of the latter kind afford a better opportunity to handle the sheep and can be operated with less effort. If it is desired that the top of the vat shall be flush with the ground, it should first be built at least 4 inches above the natural surface of the ground and then dirt or gravel may be filled in, thus obtaining proper drainage along the sides.

Whenever it is possible to do so the gravity method of draining the old dip out of the vat should be adopted, as otherwise it is necessary to pump or dip it out each time the vat is cleaned. The end of the vat having the drain should be slightly lower than the other end, so that all the liquid will drain off. The slide board into the vat should be set at an angle of 45° and extend from the floor of the chute to at least 4 inches below the dip line; it should be made of or covered with a smooth-surfaced material, such as planed lumber or sheet metal. The end extending into the dip should be flush with the vertical end of the vat. A space between the slide board and the end of the vat, if large enough for a lamb to lodge in, is a dangerous arrangement. The runway leading out of the vat should not be too steep. The length varies from 8 to 16 feet, the latter being preferable in large vats.

HEATING FACILITIES

When lime-and-sulphur dip is used it is necessary to provide cooking tanks. The cooking may be done by steam or in open boilers having a fire box under each. All large plants should have steam boilers of not less than 25 horsepower. The live steam can be piped into the dipping vat and used for maintaining the temperature of the dip, and also into the cooking and heating tanks for boiling the dip or heating water. The steam pipes should extend along the floor of the vat at least two-thirds of the length and be provided with openings for the escape of the steam into the dip. The supply pipe from the settling tank should enter the vat above the dip line, in order that any leak may easily be detected.

CARE OF PLANT WHEN NOT IN USE

A dipping plant that does not receive proper care when not in use deteriorates very rapidly. The pressure of the ground against the sides of the vat tends to cause them to bulge inward; this tendency may be counteracted to some extent by keeping the vat full of liquid. Wooden vats which are allowed to stand empty dry out, and the lumber shrinks so that the vat will leak when refilled. At the close of dipping operations the vat should be left full of liquid and water added from time to time to restore that lost by evaporation.

A week or 10 days prior to beginning dipping operations the entire plant should be overhauled and put in good condition. Before charging a new vat or one which has stood empty for some time, it should be filled with water to ascertain whether it leaks.

CONSTRUCTION OF DIPPING PLANTS

Plans for the construction of concrete and wooden sheep-dipping plants are shown in Figures 19 and 20. They are not drawn to a uniform scale; consequently, in studying the drawings the scale of each part should be noted. The plants as shown have no superfluous equipment and the arrangements are as simple as is consistent with efficiency. The size of the plant can be increased or decreased as desired. A different corral, chute, and legging-pen arrangement are shown with each vat. All parts are interchangeable and are suitable for use with either vat. Cross fences as desired can be added to the corrals. Cutting chutes are shown in both plans, as every large dipping plant should have a chute equipped with a dodge gate, so the lambs may be cut out and dipped separately.

If permanent pipes are used for conducting water and dip to the vat they should be so laid as not to act as an obstacle to the men working along the vat. There should be no obstructions to the path along both sides of the vat. The pipes can be placed under the ground, or a portable V-shaped trough can be used for conducting liquids into the vat and laid aside when not in use.

THE WOODEN VAT

As shown in the plans for the wooden vat, one side of the running chute is made of portable panels, so they may be shifted and the space converted into a legging pen. Two styles of framing are shown. In the cedar-growing sections the cedar-post frames are preferable because they do not decay rapidly, while the sawed white-pine timbers do. Where hardwood is used instead of white pine the frame timbers need not be so heavy: 4 by 4 inches is heavy enough for framing in hardwood. The frames are set from $2\frac{1}{2}$ to 4 feet apart, depending on the character of the soil and the material used; $2\frac{1}{2}$ feet apart is a safe rule, as the closer the frames are to each other the less tendency there is for the sides of the vat to bulge in between the frames. Two-inch tongued-and-grooved planks should be used in making the vat, and they should be beveled so all joints and seams may be properly calked with oakum or similar material.

THE CONCRETE VAT

In the plan for the concrete plant the corrals and chute are very conveniently arranged. The portable panels can be shifted to form either a running chute or a legging pen. The settling and screening wells shown can also be constructed as a part of any vat by changing the slope of the draining pens so the dip will run into the wells instead of down the runway. In making the forms for a draining well the groove into which the removable screen is to sit should be provided for, as well as the 4-inch opening into the vat.

The trench for a concrete vat should be excavated so the inside dimensions correspond to the outside dimensions of the vat when

completed. If the sides of the trench are smooth and reasonably firm they can be used as the outer wall of the form, but in all cases where the vat is extended above the surface of the ground it is necessary to build forms extending from the surface of the ground to the top of the vat. If the soil is sandy it will be necessary to build outer forms, in which case the trench should be wide enough to allow for these forms. The drain and other pipes shown in the drawing should be placed in the form and all should be threaded and capped, so proper connections may be made. Three pairs of one-half-inch bolts should be embedded in the concrete of the incline for attaching the false floor or runway. This floor is made of 1 by 6 inch boards laid lengthwise with cross cleats, as shown in drawings. Two pairs of bolts also should be embedded for attaching the slide board. Steam pipes should not be molded into the concrete walls, as the vibration of the pipes will crack the cement. They should pass over the top of the vat and down the side in a groove formed in the wall, so they will not come in contact with the sheep or cause annoyance to the men working along the vat.

The walls should be made 6 inches thick, constructed of concrete mixed in the proportion of 1 part cement, $2\frac{1}{2}$ parts sand, and 4 parts broken stone or gravel. This mixture is slushed into forms properly set, and when it approaches dryness the forms are removed and the inside surface of the vat coated with pure cement mixed to about the consistence of cream and applied with a brush. It is important that this coating be well brushed in so as to fill all cavities and form a smooth surface.

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March 3, 1927

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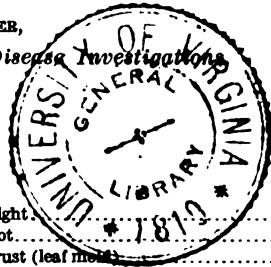
SWEET-POTATO DISEASES.

By L. L. HARTER,

Pathologist, Cotton and Truck Diseases Investigation

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INTRODUCTION.

The sweet potato holds relatively the same relation to the South that the Irish potato does to the North. Practically every farmer grows a few for home use, while some grow them for the market. In addition to many large centers in the South where sweet potatoes form the principal money crop, the industry has been intensively developed in one or two sections in the States of New Jersey, Delaware, Ohio, Illinois, Iowa, and Kansas. The small grower usually sells his surplus stock when it is dug. The big growers, on the other hand, generally store a part or all of their crop, to be placed on the market during the winter, when the prices are high.

The sections devoted to the industry are sufficiently large at the present time to supply the demand if reasonable returns can be expected. If the crop were sold in the fall when prices are low, actual

NOTE.—This bulletin is of interest to growers of sweet potatoes in the Eastern, Southern, Middle Western, and Southwestern States.

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losses would result. Consequently many storage houses have been built throughout the country with the hope that the crop may be kept and put on the market during the winter. In this undertaking some growers have succeeded, while some others have lost a large percentage of the crop from storage rots, consequently realizing less than if the potatoes had been sold in the fall for what they would bring. In some localities the losses sustained in the field together with the subsequent losses in storage have exacted such heavy toll that many farmers are tempted to abandon the industry. It is believed, however, that with a better knowledge of field diseases and storage rot and of the conditions which bring them about, together with an understanding of storage-house manipulation, much of the loss can be prevented.

In general, the purposes of this bulletin are (1) to give a brief discussion of the characteristics of the various diseases in the field and in the storage house and (2) to present methods for the control of these diseases, so far as they are known at the present time.

The sweet potato troubles may be divided into three general classes, as follows:

1. Diseases of the roots and stems (field troubles).

- Stem-rot (wilt, blue-stem, yellow blight).

- Black-rot (black-shank, black-root).

- Foot-rot (die-off).

- Scurf (soil-stain, rust, Jersey mark).

- Root-rot.

2. Diseases of the leaf.

- Leaf-blight.

- White-rust (leaf mold).

- Leaf-spot.

3. Storage rots.

- Soft-rot (collar rot, ring-rot.)

- Black-rot.

- Dry-rot.

- Java black-rot.

- Charcoal rot.

STEM-ROT (WILT, BLUE-STEM, YELLOW BLIGHT).

DESCRIPTION.

The symptoms of stem-rot caused by the fungi *Fusarium batatas* and *Fusarium hyperoxysporum* differ somewhat with different varieties. The first indication of the disease in the field is a slight difference in the color of the foliage of affected plants as compared with that of healthy plants. The leaves become duller in color, then yellowed between the veins and somewhat puckered, these symptoms being followed by wilting of the affected vines (fig. 1). The youngest or apical leaves are generally the first to show signs of

disease. If the stem of a diseased plant be pinched open it will be found to be blackened inside. This discoloration sometimes extends 3 to 5 feet from the hill and is a sure sign of stem-rot. Later the stem ruptures and the surface becomes blackened and rotted, though the plant may produce a few potatoes, on which sprouts frequently develop. The organism causing stem-rot may also invade the roots, forming a blackened ring about a quarter of an inch below the surface (fig. 2). If such potatoes are used for seed the sprouts developed therefrom are likely to be diseased.



FIG 1.—A sweet-potato plant showing the characteristic symptoms of stem-rot.

In the hotbed the symptoms of the disease are similar to those in the field. Diseased plants can generally be detected by the faint purplish tint which is cast through the white part of the stem and by the yellow discoloration of the leaves.

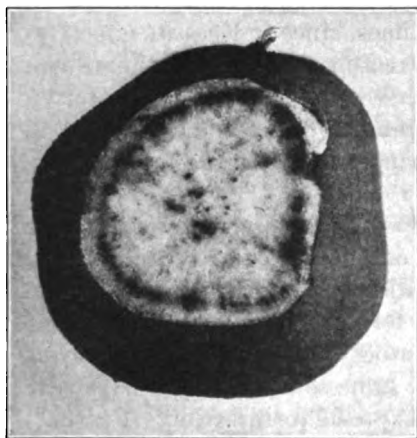


FIG. 2.—Sweet-potato stem-rot. A section through a sweet potato showing the blackened ring just below the surface caused by the stem-rot fungus.

CONTROL.

Fertilizers and fungicides ineffective.—In view of the fact that the fungus causing stem-rot invades the interior of the plants, fungicides can not be expected to give any relief. The application of lime and gypsum to the soil is of no value.

Seed selection.—It has already been pointed out that the fungus invades the roots of the sweet potato and lives over in the potatoes in the storage house; also that the fungus grows from diseased seed potatoes into the plants developed from them. In the early stages

these diseased plants are hard to detect, and, in consequence, many of them are set in the field, where the growth of the fungus continues. It is, therefore, imperative that only healthy potatoes be used for seed. Healthy seed can be secured by selection in the fall at digging time, while the potatoes are still attached to the vines. Each hill should be tested by splitting the stem, and potatoes should be taken for seed only from plants the insides of which are not streaked with black. It should be remembered that a heavy frost will also produce the blackening of the bundles, similar to stem-rot. The fall selection of seed is necessary, owing to the fact that in the spring or during the winter it is difficult and frequently impossible to tell whether the potatoes are diseased or not, since after a period in storage the bundles of healthy potatoes often become somewhat darkened, even though the fungus is not present. The potatoes selected for seed should be stored in baskets in a part of the house where they will not come in contact with the general stock.

In the spring the seed potatoes should be disinfected just before bedding by treating for 5 to 10 minutes in a solution made by dissolving 1 ounce of corrosive sublimate in 8 gallons of water. Only wooden vessels should be used for disinfection. Corrosive sublimate is a strong poison and should be kept out of the reach of animals. After the potatoes are disinfected they should be rinsed in pure water and laid in the sun to dry. This treatment will not kill the stem-rot fungus within the potato, but it will destroy any spores that may be on the surface. The solution of corrosive sublimate should not be used more than two or three times, since it loses its effectiveness after repeated use. If for any reason corrosive sublimate can not be used, the potatoes may be immersed for 5 minutes in a solution of formaldehyde made by adding 1 pint of commercial formalin to 30 gallons of water. They should be rinsed in water and dried before bedding.

Preparation of the hotbed.—The repeated use of the same soil year after year in the hotbed is probably one of the chief sources of the distribution of many sweet-potato diseases. This soil, after the hotbed season is over, is often either left in the beds or thrown out to one side with all the decayed potatoes and manure. The germs contained therein multiply, and if the same soil is used the next year the potatoes and plants are at once exposed to infection. Furthermore, when bedding their potatoes, farmers frequently throw the diseased potatoes out to one side. These eventually become mixed with the soil, and the disease germs are carried on the shoes and by chickens, etc., to the hotbed. As a result of such unsanitary methods hotbeds which might otherwise produce healthy plants become badly infested.

Soil once used in the hotbed should be hauled away, and all the rubbish around the bed raked up and carted off. The framework of the hotbed and the ground around it should be thoroughly soaked with a solution of formaldehyde made by mixing 1 pint of formalin and 30 gallons of water, or, if preferred, with a solution of copper sulphate made by dissolving 1 pound of copper sulphate in 25 gallons of water. It is advisable that this treatment be repeated after about 24 hours. The soil for the hotbed, or preferably sand, should be obtained from some place where sweet potatoes have never been grown, if possible from some high spot in the woods. The upper 6 inches of the soil should be thrown away and only subsoil used. Rich dirt is not necessary for the hotbed; in fact, some of the best results have been obtained by the use of pure sand. The same farm implements used to handle and haul away the old dirt should not be used to handle new soil or sand without being cleaned and disinfected with a solution of either formalin or corrosive sublimate. A grade of subsoil should be used that will not bake or form a crust through which the sprouts can not emerge.

In regions where sweet-potato diseases occur, the use of stable manure in the hotbed is a practice of doubtful value, since potatoes discarded or fed to stock find their way too easily to the manure pile. However, stable manure may be safely used if great care is exercised to cook all decayed or diseased potatoes before feeding them to stock and never to throw them out in the yard, where infected parts may be carried around on the feet of chickens, farm animals, etc.

Crop rotation.—It has already been pointed out that a fair percentage of infection takes place in the field. Although healthy plants may be grown by careful seed selection and care in the preparation of the hotbed, the effort is largely wasted if the plants are set on infected soil. It is, therefore, imperative that the plants be set on new ground or ground which has not produced sweet potatoes for several years.

It is not definitely known how long the stem-rot fungus will live in the soil in the absence of sweet potatoes, but probably for several years. For that reason, sweet potatoes should not be planted on the same ground oftener than once in three or four years. It is very doubtful whether that length of time will completely eradicate the fungus, but it certainly will greatly reduce it. No other crops are known to be attacked by the stem-rot fungus; therefore, any crops commonly grown in the region may be used in the rotation.

Slip seeding.—By slip seeding is understood the practice of cutting up the vines so as to include at least two buds or leaves and sticking one end, usually the larger, into the ground, the potatoes produced therefrom to be used for seed for the next year's crop. Slip

seeding is a practice generally followed in some localities and not at all in others. When intelligently done it is an efficacious means of controlling sweet-potato diseases. However, if practiced independently of all sanitary measures it is of little value. The writer has examined quantities of slip-seed stock, both in the field and in storage, and found an abundance of stem-rot, black-rot, foot-rot, and practically all of the diseases present in that particular locality. In regions where the disease germs are not present in all soils beneficial results have been obtained.

To obtain results from slip seeding the following precautions must be taken:

(1) The cutting should be made from healthy vines. This will seem obvious when it is remembered that the organism causing stem-rot often grows out into the vines 4 to 5 feet from the hill and it can not always be detected without pinching open the vine.

(2) The cuttings must be planted on new ground or on ground on which sweet potatoes have not been grown for at least six years.

(3) The potatoes produced by the cuttings must be picked over and disinfected in the spring before bedding, according to directions already given.

(4) The seed potatoes must be bedded in a hotbed prepared according to the directions given above.

DISTRIBUTION, PREVALENCE, AND LOSS.

Stem-rot is known to be prevalent in the States of New Jersey, Delaware, Maryland, Virginia, Illinois, Iowa, Kansas, Alabama, and Arkansas and to be present in Missouri, North Carolina, Ohio, Georgia, Texas, Oklahoma, and Mississippi. It is likely that the disease occurs in other States also. In some States the disease is at present relatively unimportant, owing to the fact that varieties have been grown which are somewhat resistant to it or to the fact that the sweet-potato industry is comparatively new and the disease has not yet become serious.

The losses sustained from stem-rot can only be estimated, but in New Jersey alone 10 to 50 per cent of the crop is destroyed each year, and fields have been found where 95 per cent of the plants were killed. In States like New Jersey and Delaware, where the sweet potato forms an important money crop, the losses annually amount to many thousands of dollars. Conditions are equally bad in Iowa, parts of Kansas, and in southern Illinois. In Maryland, Virginia, and Alabama, although the losses are considerable each year, they are relatively less than in New Jersey, Delaware, Iowa, and Kansas. In other States where the disease occurs the losses at the present time are comparatively small. At the most conservative estimate, stem-rot is responsible for a loss of at least three-quarters of a million dollars annually to the sweet-potato crop in the United States.

HOW STEM-ROT IS DISTRIBUTED.

Stem-rot must be considered from the standpoints of its distribution (1) from one field to another and (2) from one locality or State to another. It must be kept in mind that this fungus will live throughout the winter in the soil on the remains of dead sweet-potato vines and in the potatoes in storage. Therefore, the distribution of the disease from one field to another may be brought about by such agencies as (1) insects, (2) farm animals which are allowed to roam from one field to another, (3) farm implements, (4) drainage water, (5) wind, and (6) by the dumping of discarded diseased roots on the fields as fertilizer, either before or after feeding to stock.

The distribution of the disease over wide areas is brought about primarily by the exchange or sale of seed potatoes and plants; in fact, many growers in Illinois, Iowa, and Kansas claim that the disease was not known to them until they imported seed potatoes from Eastern States. Furthermore, some farmers grow plants for sale and send them long distances to other States. In some cases the appearance of the disease in a locality can be definitely traced to the importation of seed potatoes and plants.

It might be advisable as a means of protecting both the plant growers and the farmers buying plants if a system of inspection and certification of establishments by the State pathologist or other duly authorized persons was practiced. Such a system would, it is believed, restrict the spread of some of the worst diseases and protect the growers against loss. The plant-growing establishments would find it imperative to rid their stock of the various diseases, and in the end would be able to place on the market perfectly healthy plants, thereby being protected against claim from the growers for the sale of diseased plants.

CAUSE OF STEM-ROT.

Two different fungi, or moldlike plant growths, cause the stem-rot of sweet potatoes. They are *Fusarium batatas* and *Fusarium hyperoxysporum*. These two fungi are closely related to other organisms causing similar diseases, such as the wilt of cotton, cow-peas, watermelons, tomatoes, and Irish potatoes. The organisms causing stem-rot of the sweet potato, however, will not under natural conditions attack any other plants. Neither will other organisms causing similar diseases in other plants attack the sweet potato.

So far as known, stem-rot originated in the United States; at any rate it has never been reported from other countries. It was first reported from New Jersey in 1890. According to the testimony of many old growers it was known many years before that, but had not

attained economic importance. These organisms, like many others of their kind, can live for several years on decayed vegetation in the soil until they again come in contact with the sweet potato.

Infection undoubtedly takes place through the roots, either in the field after the plants are set out or in the hotbed by growing from diseased potatoes into the plants. Such infected plants when set in the field soon die.

The mycelium or vegetative part of the fungus develops rapidly and often enters the root and grows up into the water-carrying vessels of the stem, where it forms a barrier to the passing of water and plant food from the roots to the leaves.

Following the death of the plant the vines turn black, the fungus living thereafter on the decaying vegetation. On the dead vines numerous fruiting bodies, or spores, are developed. The spores are somewhat curved and several celled, as shown by figure 3. Being very

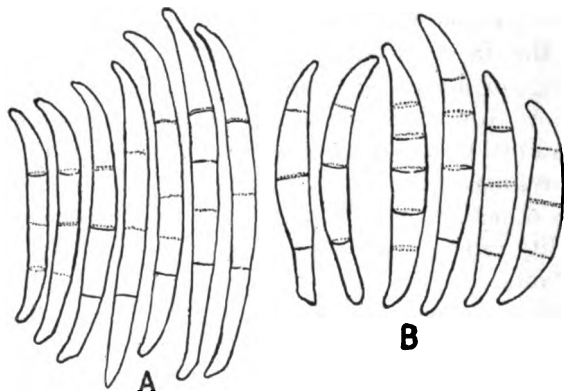


FIG. 3.—Spores of the two stem-rot organisms: A, *Fusarium batatatis*; B, *Fusarium hyperozysporum*. $\times 500$.

small, they are readily carried by the wind, insects, and other agencies to other fields, where new infections may arise.

BLACK-ROT (BLACK-SHANK, BLACK-ROOT).

DESCRIPTION.

Black-rot, caused by the fungus *Sphaeronema fimbriatum*, may occur on any of the underground parts of the plant. On the potato it is characterized by the dark to nearly black, somewhat sunken, more or less circular spots on the surface (fig. 4). In the early stages these spots are small and nearly round, but under favorable conditions they enlarge, until frequently nearly the whole potato is involved. Often in the center of the spots will be seen more or less circular areas, from one-fourth to one-half inch in diameter, in which may be found fruiting bodies of the fungus causing the disease. The surface of the diseased spots has a somewhat metallic luster and the tissue just beneath is greenish.

On the plants the infection begins as small black spots, which gradually enlarge until the whole of the stem is rotted off. Fre-

quently it extends up the stem to the surface of the soil (fig. 5). It is important to remember that if black-rot potatoes are used for seed

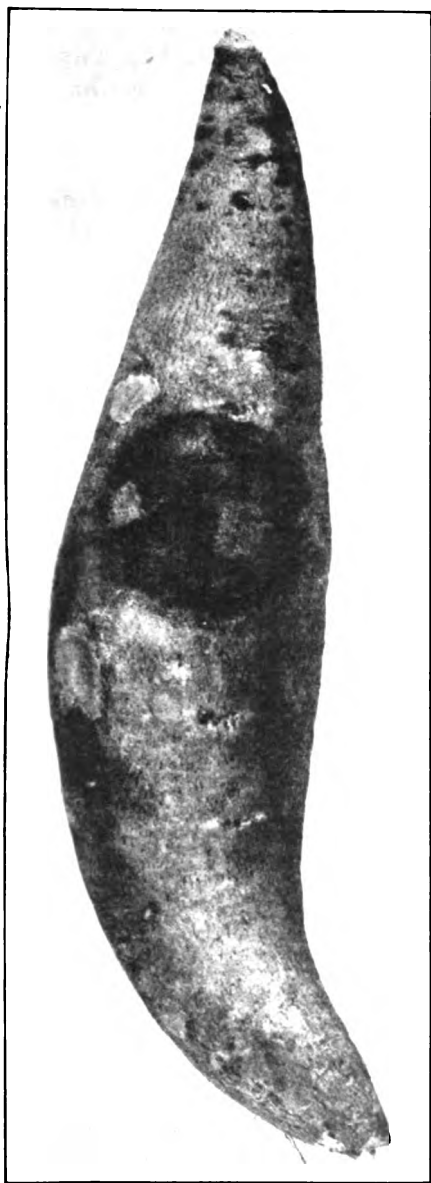


FIG. 4.—Sweet-potato black-rot. A sweet potato showing the black circular spot produced by the black-rot fungus.



FIG. 5.—Sweet-potato black-rot. Small sweet-potato plant, showing the characteristic blackening of the underground part of the stem.

the plants coming from them will be likely to have black-rot.

All sweet-potato growers are well aware that when cooked, black-rot sweet potatoes have a very disagreeable taste. Therefore, farmers

should be very careful not to sell such potatoes (1) because their sale has a bad effect upon the market and (2) because it may be

the means of carrying the disease into an uninfected locality. Many more sweet potatoes would be consumed in the cities if fewer bad potatoes were being sold. The consumer after buying a small quantity and finding none of the potatoes fit to use is not likely to risk another purchase. There may be a temptation to sell bad potatoes to the unsuspecting consumer, but it is bad policy to do so; he will merely retaliate by not buying any more.

CONTROL.

The same control methods in general should be applied to black-rot as to stem-rot, particularly the preparation of the hotbed, the selection of seed potatoes, and crop rotation. If black-rot alone is concerned, the seed can be selected in the spring instead of in the fall. If seed is selected in the fall it should be picked over again in the spring and any potatoes with suspicious spots on them discarded.

The treatment of the soil with sulphur, lime, gypsum, or different fertilizers has little or no effect on the disease. Dipping the slips in a solution of Bordeaux mixture or in a lime-sulphur mixture just before setting them in the field does not prevent the disease, but has been found greatly to injure the plants.

DISTRIBUTION, PREVALENCE, AND LOSS.

Black-rot was reported for the first time in 1890 in New Jersey, but it is likely that it occurred long before that. Since then it has been found in practically every part of the United States where sweet potatoes are grown and also in the West Indies and New Zealand.

The disease is known to occur in New Jersey, Delaware, Maryland, Virginia, Ohio, Illinois, Missouri, Iowa, Kansas, Oklahoma, Texas, Arkansas, North Carolina, South Carolina, Georgia, and Alabama, and it is probable that it occurs wherever sweet potatoes are grown. Black-rot has been found on the following varieties: Nancy Hall, Yellow Jersey, Big-Stem Jersey, Red Bermuda, Miles Yam, White Yam, Southern Queen, Pierson, Early Red Carolina, Florida, Yellow Strassburg, Key West Yam, Red Jersey, Dahomey, Red Brazilian, Yellow Yam, Vineless Yam, and Georgia.

In all the regions mentioned the disease is prevalent on the plants or slips in the hotbed and on the potatoes in the storage houses in the winter; in fact, heavy losses are caused by this disease in storage houses, where it develops freely under favorable conditions and renders the potatoes unfit for consumption.

HOW BLACK-ROT IS DISSEMINATED.

In general, black-rot is disseminated in about the same way as stem-rot. Unlike stem-rot, however, black-rot spreads freely through the storage house under favorable conditions. Small flies and other

insects carry the spores on their bodies from diseased to healthy potatoes, where, if conditions are favorable, a new infection takes place. Distribution in the storage house may also be brought about by the handling of potatoes when they are picked over and prepared for the market or by settling in the bins.

CAUSE OF BLACK-ROT.

Black-rot is caused by the fungus *Sphaeronema fimbriatum*. It is a disease of the underground parts of the plant. Infection takes place through the roots, either coming from the soil after they are set in the field or by growing on the plants in the hotbed from diseased potatoes used for seed. Plants diseased so early in their life soon die, rarely producing any potatoes. This fungus, like many others of its kind, lives from one year to another on the dead vines or other decayed vegetable matter in the soil until it comes in contact with a sweet-potato plant.



FIG. 7. — Sweet-potato black-rot. A chain of colorless bodies which break apart and serve to reproduce the fungus.

The reproduction and spread of the black-rot fungus is provided for by three different types of spores borne in the black, decayed portion of the young plant below the soil and in the roundish, sunken, dead spots on the potatoes. One type of spore is colorless and round and is borne in great numbers inside a minute flask-shaped receptacle called the pycnidium, with a long, thin neck, as shown by figure 6. These spores pass out through the neck of the pycnidia and accumulate on the end in the form of a whitish viscid mass, and are carried by insects and other agencies to various places, where new infections may start. Buried in the dead tissue of the host are found brown spherical bodies with thick walls, which may serve to carry the disease from one season to the next. The mycelium is branched and mostly colorless, but differs from that of many other fungi in that it may break up into a large number of parts, each of which functions as a spore. These parts are colorless, cylindrical, and slightly rounded at the end, averaging about four times as long as broad (fig. 7).

FOOT-ROT (DIE-OFF).

DESCRIPTION.

Foot-rot appears first as small brown to black spots on the stem of the plant near the soil line. Its growth at first is very slow, but



FIG. 6. — Sweet-potato black-rot. A pycnidium of the black-rot fungus in which are contained innumerable hyaline spores.

eventually it girdles the plant and extends up the stem 4 or 5 inches. Soon thereafter wilting of the plant begins, and round, black, rather numerous specks, just visible to the naked eye, appear in the diseased areas (fig. 8). These specks are the fruiting bodies of the fungus causing the disease. Owing to the fact that this disease pro-

gresses rather slowly, it is about midsummer or later before the plants begin to die off. In most instances no potatoes are found in the affected hills, though long vines may have been produced.

The organism causing foot-rot may grow from an infected stem on to the roots and cause a brown, rather firm rot of the potato. Later, fruiting bodies standing close together develop on the surface in the form of pimple-like protuberances (fig. 9). Many wounds and bruises on potatoes in storage are infected with the foot-rot fungus.

CONTROL.

The same control measures should be employed for this disease

FIG. 8.—Sweet-potato foot-rot. The lower part of a sweet-potato plant killed by the foot-rot fungus. Note the fruiting bodies embedded in the diseased tissue.

as for stem-rot and black-rot—namely, seed selection, the use of clean seed beds, and crop rotation.

DISTRIBUTION, PREVALENCE, AND LOSS.

Foot-rot is distributed in the same way as stem-rot and black-rot, through diseased soil, exchange of plants or seed potatoes, etc.

Foot-rot is known to occur in Virginia, Ohio, Iowa, and Missouri, and it is likely that it occurs elsewhere.

Owing to the fact that it is not so widely distributed, the total loss that may be attributed to this disease is much less than that



due to black-rot and stem-rot. In localities where it does occur, however, it produces greater loss than either of those diseases. In certain sections of Virginia, Ohio, and Iowa it has been estimated to produce a loss of 50 per cent of the crop in one year.

CAUSE OF FOOT-ROT.

To the fungus causing foot-rot the name *Plenodomus destruens* has been given. This organism is similar to a large group of fungi causing diseases in other plants, as, for example, some of the leaf-spots. It does not, however, attack any plants other than sweet potatoes so far as known.

Foot-rot was first discovered in 1912 in Virginia. There is no doubt that it existed some years previous to that time. It is often confused with black-rot and stem-rot by farmers and probably for that reason it was not recognized earlier as a distinct disease.

Infection takes place primarily through the roots or underground parts of the plant, though during wet periods, when the growth is very luxuriant, diseased vines are sometimes found some distances from the hill. Like stem-rot and black-rot, infection takes place either in the field after the plants have been set out or in the hot-bed by growing from diseased potatoes on to the plants. Such plants, when set in the field, usually die early in the season, or at any rate seldom produce any potatoes. The growth of the fungus is very slow at first and it is usually midsummer before field infections produce any marked injury. The organism advances along the stem to 4 or 5 inches above the soil line, turning the surface brown. About this time the vine wilts and the plant dies. In the diseased tissue pimply, domelike projections, the pycnidia, just visible to the naked eye, can be seen scattered over the surface. The spores, (fig. 10, A), borne in great numbers, escape from the pycnidia (fig.

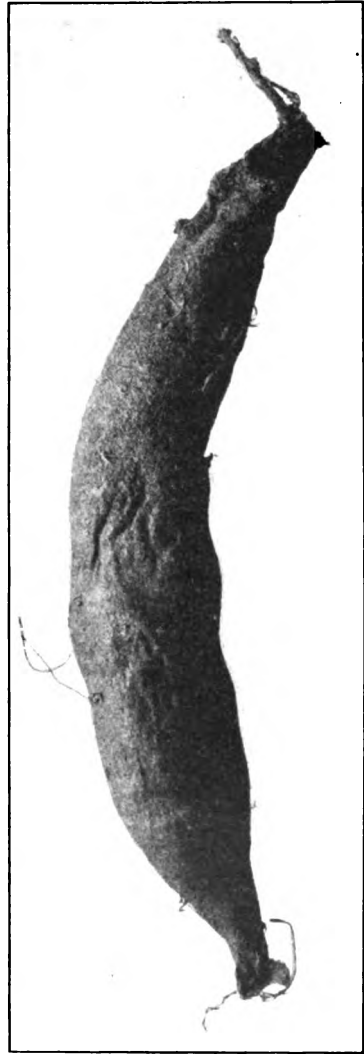


FIG. 9.—Sweet-potato foot-rot. A sweet potato rotted by the foot-rot fungus. Note the fruiting bodies crowded together over the surface.

10, *B*) and are carried by insects or other agencies to other plants, where new infections may result. The fungus may live as a saprophyte for several years on the dead vines or other decayed vegetable matter.

It is important to remember that this fungus can carry on a saprophytic existence where the host is not present. This enables it to remain much longer in the soil than would otherwise be the case. If a diseased plant produces potatoes the fungus often grows down the roots and infects the potatoes. Here it may remain dormant during the storage period, but will develop in the hotbed and infect the plants produced. Like stem-rot and black-rot, there-

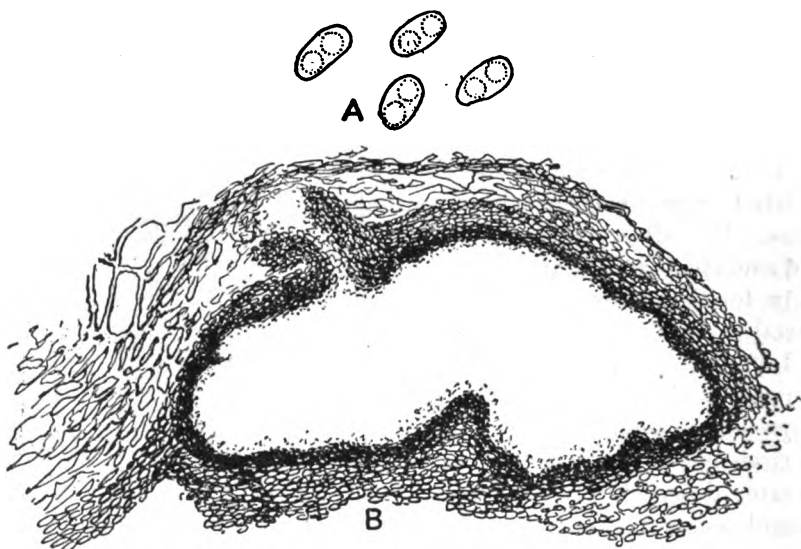


FIG. 10.—Sweet-potato foot-rot: *A*, Spores of the foot-rot fungus; *B*, a fruiting body in which the spores are borne.

fore, diseased seed potatoes give diseased plants, which in turn may produce diseased potatoes in the field. By this means the disease may be carried along with the crop indefinitely.

SCURF (SOIL-STAIN, RUST, JERSEY MARK).

DESCRIPTION.

Scurf is characterized by a brown discoloration of the surface of the underground parts of the sweet-potato plant (fig. 11). The discolored areas may take the form of spots of varying sizes and shapes with no definite outline or there may be a uniform rusting of the entire surface of the potato. The scurf produces no rupture of the sweet potato and is so superficial as to be easily scraped off by the finger nail.

CONTROL.

To control this disease the seed potatoes should be disinfected for 10 minutes in a solution made by dissolving 1 ounce of mercuric chlorid in 8 gallons of water. They should then be dipped in water and dried. Soil or sand obtained from the woods or from fields where sweet potatoes have never been grown should be used in the hotbed. The plants should be set in new ground or ground never before used for sweet potatoes.

Scurf is worse on heavy soils and on soils containing a large quantity of organic matter, such as manure. Such soils should be avoided. It is likewise worse during a wet season and on low wet ground. The treatment of the soil with fungicides or fertilizers has not been found effective as a means of control.

DISTRIBUTION, PREVALENCE, AND LOSS.

Scurf is very common, having been found in Arkansas, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Ohio, Illinois, Iowa, Texas, and Kansas, and on practically all varieties.

The loss to the crop caused by scurf is perhaps small in comparison with some of the other more serious diseases; nevertheless, the actual financial loss throughout the country that can be attributed to this disease

alone amounts to considerable. Scurfy potatoes do not command as high a price in the market as clean ones, though if otherwise sound they are just as good for food. The scurf under favorable conditions, such as a relatively high humidity and temperature, continues to develop under storage conditions to a limited degree. It weakens the



FIG. 11.—Sweet-potato scurf. A sweet potato, showing discoloration caused by the scurf fungus.

host, so that during periods when the storage house is rather dry the potato loses moisture and becomes shriveled and dried.

CAUSE OF SCURF.

Scurf is caused by the fungus *Monilochaetes infuscans*. The causal organism is a brown, unbranched fungus, bearing a colorless spore at the end (fig. 12). The mycelia and spores live through the winter on the potatoes in storage and on the decayed vines in the field. So far as known the fungus does not attack any other host. If infected potatoes are used for seed, the fungus grows on to the plants and is carried by them to the field. The organism produces



FIG. 12.—Sweet-potato scurf. A sporophore bearing a hyaline conidium of the scurf fungus. These bodies occur only on the surface of the underground parts of the plant.

no apparent injury to the plants in the hotbed or in the field, but it continues its growth and follows down the roots to the potatoes. The spores may be produced at any time, provided there is a high percentage of moisture present and the temperature is high enough for their growth, that is, about 50° to 85° F. It is likely, however, that the disease can be propagated by the threads, or hyphæ, which are produced in considerable numbers. The organism causing scurf will grow for a considerable time as a saprophyte in the absence of the sweet potato. Wet soils and soil containing a large quantity of organic matter are favorable to the disease. This fact has been recognized by many growers, and the disease is thought by them to be a stain caused by manure or organic matter.

ROOT-ROT.

DESCRIPTION.

This disease is best known as the Texas root-rot of cotton and alfalfa. The causal organism gains access to the plants on the underground parts and spreads in both directions, invading the vines for 6 to 12 inches above the ground. It may enter the potato at the end or form lesions of varying sizes on the surface. In either case a firm brown rot is produced, resulting in the complete destruction of the potato (fig. 13). Above ground the growth is within the stem and may be detected by the brown discoloration produced. The organism lives from one season to the next in the soil on dead vegetable matter, or in the far South probably on growing winter crops. It is killed by hard freezing, and this alone probably restricts the fungus to the Southern States.

CONTROL.

Root-rot is worse on black, poorly drained soil and during wet seasons. The disease is particularly difficult to control or eradicate because it has such a great variety of hosts. Deep, clean cultivation, aeration of the soil, and crop rotation are important in controlling the disease in cotton. The same methods, together with the careful selection of disease-free potatoes for seed, should be employed for sweet potatoes. The fungus attacks a great variety of plants, both wild and cultivated. It has not been known, however, to injure corn or any of the cereals, so these crops should be used in the rotation.

DISTRIBUTION, PREVALENCE, AND LOSS.

Root-rot, so far as known, occurs only in Texas, New Mexico, Oklahoma, and Arizona. When the disease once gets into a field a whole crop may be destroyed. Large fields have been seen in which not more than 10 per cent of a crop was produced. Viewed from a distance, the field looked promising, but when harvested the potatoes were nearly all found to be destroyed by the fungus.

The disease may occasionally be observed as early as May or June, but it is in August that it becomes really serious. By this time the vines are well developed and the potatoes of considerable size. The disease from this time increases in severity, so that by September and October, when the potatoes are dug, it has practically destroyed a large percentage of the crop. It may occur in localized spots. Not all hills and not all the potatoes in a hill are completely destroyed, though fields have been examined where 90 per cent of the crop was lost.

CAUSE OF ROOT-ROT.

Root-rot is caused by the fungus *Ozonium omnivorum*. No spore stage of this organism is known, and it presumably lives from one



FIG. 13.—Root-rot. A sweet potato showing the characteristic shriveling produced by the root-rot fungus.

season to the next by means of the hyphæ, which are brown, septate, and branched, the branching being nearly at right angles. The mycelia, or hyphæ, are produced on the surface in the form of grayish wefts or strands, which can be easily recognized with a hand lens by one familiar with the disease. Under the microscope the strands are seen to be composed of interwoven hyphæ of the root-rot fungus.

LEAF-BLIGHT.

Leaf-blight is caused by a fungus known as *Phyllosticta batatas*. It appears on the upper side of the leaf as roundish or angular spots,

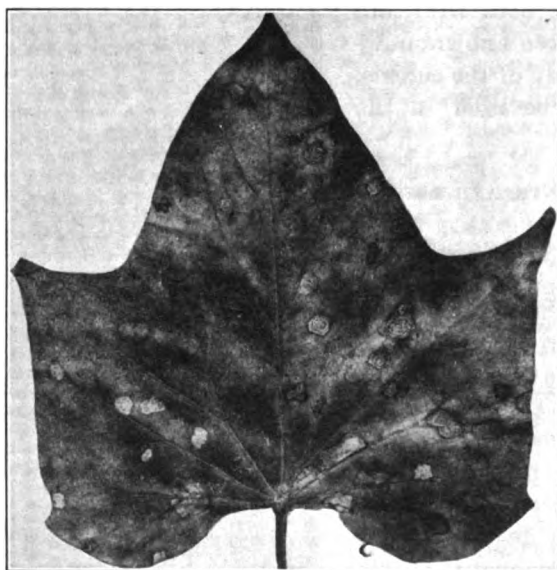


FIG. 14.—A leaf of a sweet-potato plant, showing the presence of a number of circular leaf-blight spots. Note the numerous black specks, within the spots, in which the spores are borne.

one-eighth to one-half an inch in diameter (fig. 14) and separated from the healthy tissue by a dark line. Inside this line is a strip of brownish tissue which has lost most of the green color. Still inside this ring is a circular area, much lighter in color, in which a number of black bodies are found. These black bodies, the pycnidia, about the size of a pin point and just visible to the naked eye, may take a more or less circular arrangement,

or they may be scattered indiscriminately within the spot. The pycnidia are slightly raised and rounded in a domelike manner and contain numerous colorless spores. So far as is known the fungus is not parasitic on any other plant; neither does it occur on other parts of the plant than the leaf. It is thought to live through the winter on the dead leaves. The disease occurs every year in the Southern States and attacks primarily the mature leaves.

Leaf-blight occurs practically everywhere in the Southern States, but is less common as far north as New Jersey, Delaware, Maryland, Iowa, Kansas, and Illinois. The *Phyllosticta* leaf-blight has never been serious enough to require remedial measures.

LEAF-SPOT.

Leaf-spot, caused by *Septoria bataticola*, similar in general appearance to leaf-blight, occurs on sweet potatoes. The spots, one-fourth to one-eighth of an inch in diameter, are scattered indiscriminately over the foliage (fig. 15). They are white, surrounded with a brown border. Within these white areas one or more black specks, the pycnidia, just visible to the naked eye, may be found. In the pycnidia are contained numerous spores, which upon escaping from the pycnidium are carried by insects or other agencies to other leaves, where a new infection may start. Like the organism causing leaf-blight, this fungus is not known to be parasitic on other plants or other parts of the sweet potato. It probably winters over on the dead leaves in the field.

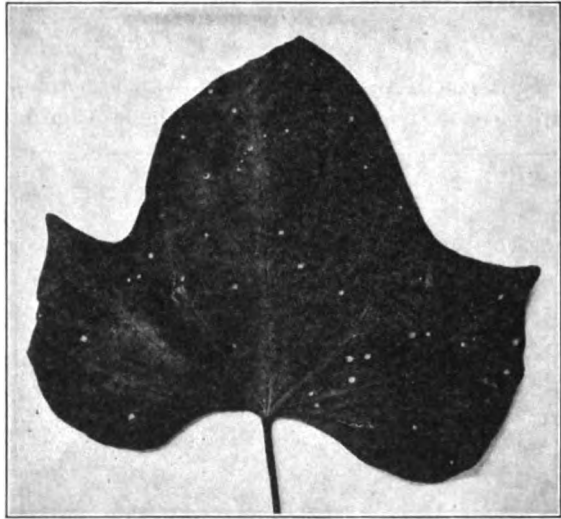


FIG. 15.—Leaf-spot. A leaf of a sweet-potato plant showing white spots caused by the leaf-spot fungus.

Leaf-spot is very widely distributed, having been collected in New Jersey, Delaware, Iowa, and other States where sweet potatoes are grown. This disease is nowhere serious enough to require remedial measures.

WHITE-RUST (LEAF MOLD).

The first symptom of white-rust is a loss of the green color in indefinite spots on the under side of the leaf (fig. 16). Later, these spots become brown and covered with a whitish, viscid growth, which is finally more or less powdery. This white powdery mass is made up of numerous spores or reproductive bodies, which serve to start a new infection if they fall on another leaf and conditions are favorable, such as a high temperature and a relatively high humidity. Frequent rains and heavy dews are favorable to the spread of this disease. No great amount of harm results from the attack of this fungus, though it may sometimes produce swellings on the stems and petioles and malformations of the leaves. White-rust is widely

distributed and occurs on a number of other plants, among them the wild morning-glories. This disease has never been serious enough to require remedial measures.

White-rust is caused by a fungus known as *Albugo ipomoeae-panduranae*. It is more prevalent during wet seasons. It has been found in New Jersey, Iowa, Virginia, and Maryland, and probably occurs in many other States.

STORAGE ROTS.

SOFT-ROT.

Soft-rot, due to a mold known as *Rhizopus nigricans*, is one of the most destructive diseases in the storage house. The decay begins

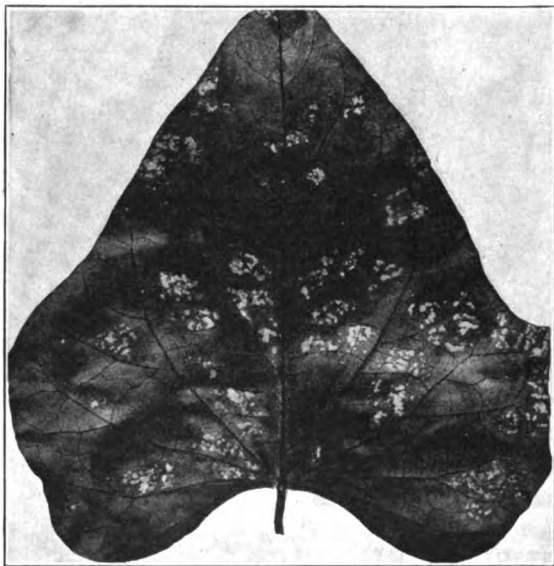


FIG. 16.—White-rust. A leaf of a sweet-potato plant, showing the white-rust fungus.

at one end of the potato and continues its growth rapidly, requiring but a few days in the presence of high temperatures and a relative high humidity to destroy the entire potato. Usually soft-rot sets in soon after the potatoes are stored and continues more or less throughout the storage period, depending largely upon the management of the house. The potatoes are first rendered soft, watery, and stringy. After

decay and following the escape of moisture the potatoes become gradually firm, hard, and brittle. Such dry potatoes are frequently referred to by the farmer as being affected with a dry rot, while in reality it is a dried soft rot. If the skin is ruptured while it is still soft, the causal organisms form a moldy growth on the surface (fig. 17). One soft-rot potato may be the means of communicating the disease to numerous potatoes lying close to it. The spores of the black mold produced on the surface may be carried by flies or communicated to other potatoes by handling in the same house, where new infections may take place if the temperatures are sufficiently high and an abundance of moisture is present.

RING-ROT (COLLAR ROT).

Ring-rot is caused by the same mold (*Rhizopus nigricans*) as soft-rot. It differs from soft-rot in that the decay begins at a point between the two ends instead of at the ends. From the point of infection the decay forms a ring or collar around the potato, while at the same time it extends slowly toward the two ends. Under favorable conditions the potato may be wholly destroyed. If, on the other hand, conditions unfavorable for its further development exist, such as a relatively low humidity and low temperatures, it may develop no further than to form around the potato a ring or collar (fig. 18), varying in width from 1 inch to 2 or 3 inches.

The losses sustained in storage from soft-rot and ring-rot amount to many hundreds of thousands of dollars annually. The fungus causing soft-rot is the common bread mold. It is found everywhere and will grow on almost any decaying vegetable matter. It is, therefore, impossible to exclude it from storage houses. It is a mold, however, which generally gains an entrance through wounds and bruises made on the potato by rough handling. In the presence of an abundance of moisture and high temperatures, the fungus growing in the wounds destroys the potato.

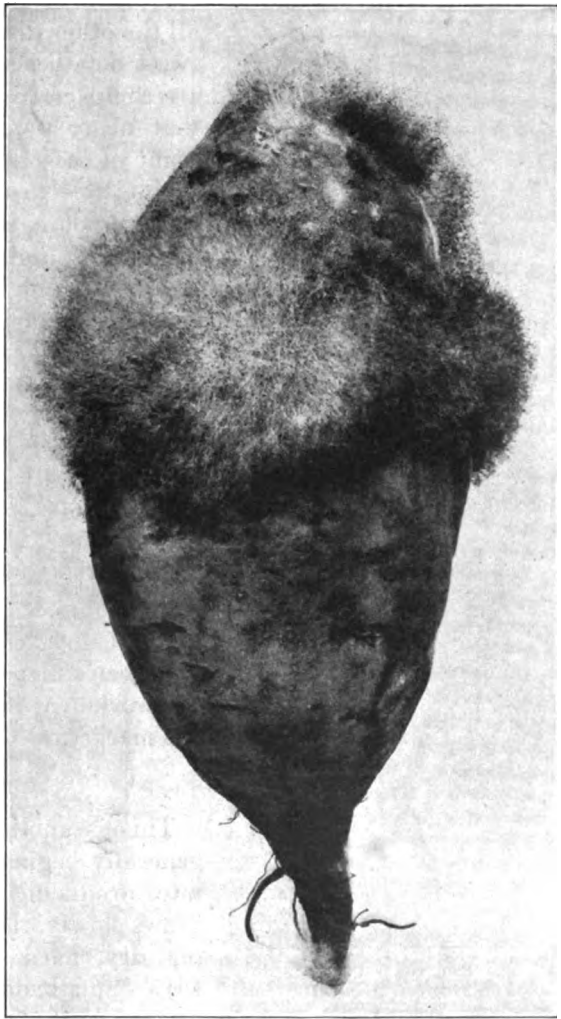


FIG. 17.—Soft-rot. A sweet potato showing the moldy growth of the fungus causing soft-rot.

BLACK-ROT.

Black-rot, caused by *Sphaeronema fimbriatum*, although a serious disease of the plants in the hotbed and in the field, as has already been shown, is a storage rot as well. The loss throughout the country caused by it in storage and in the field probably equals that of

all the other diseases combined. When sweet potatoes are dug, black-rot spots are comparatively rare, but it is likely that many potatoes are infected, the point of infection being so small as to be invisible to the naked eye. In the storage house, in the presence of comparatively high temperatures and a relatively high humidity, these spots gradually enlarge, and at the end of a month or two they have formed conspicuous, somewhat round sunken spots on the surface of the potato (see fig. 4). Near the center of these spots are numerous flask-shaped fruiting bodies, from which exude myriads of small spores. These readily adhere to the bodies of insects and are carried to other potatoes, where infection takes place if sufficient moisture is present. The germs may also be scattered about by workmen preparing potatoes for the market.



FIG. 18.—Ring-rot. A sweet potato showing ring-rot, frequently found in storage houses.

eye finally cover the entire surface. If the epidermis is scraped slightly, the tissue beneath presents a coal-black, carbonaceous appearance. Several weeks are required under normal conditions for this organism to completely destroy a potato.

Dry-rot is caused by a fungus known as *Diaporthe batatatis*. In the little domelike protuberances (fig. 19) on the surface are to be found myriads of colorless spores, which serve to reproduce the fun-

DRY-ROT.

This is another form of rot which generally begins at the end of the potato, producing a firm brown rot. It grows slowly, the potato finally becoming dry, hard, and mummified (fig. 19). Small domelike or pimplelike protuberances just visible to the naked

gus. The dry-rot fungus grows on the stems and vines above ground under field conditions, and it is here probably that potatoes become infected. It has on many occasions been found on the stems of young plants in hotbeds.

Dry-rot is widely distributed throughout the country and is frequently met with, but it can in no sense be regarded as one of the more serious storage troubles.

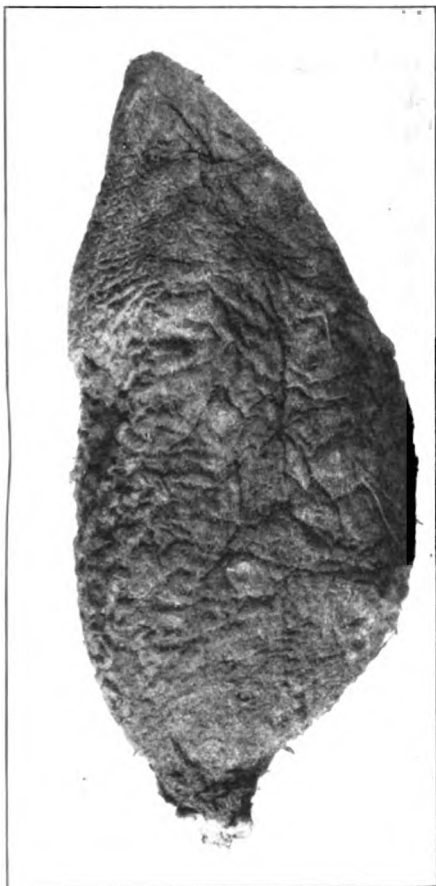


FIG. 10.—Dry-rot. A sweet potato showing the characteristic appearance of dry-rot.



FIG. 20. — Java black-rot. A sweet potato showing the dry, mummified condition produced by the fungus. Note the numerous pimplelike protuberances containing spores borne on the surface.

JAVA BLACK-ROT.

Java black-rot, so called because its discovery on potatoes grown from an importation from Java suggested that the disease might have been introduced from that country, is widely distributed in storage houses, but is more prevalent in the South.

The disease is caused by the fungus *Diplodia tubericola* and is strictly a storage trouble. It slowly renders the potatoes dry, hard,

brittle, coal black within, and difficult to break (fig. 20). It is reproduced by brown 2-celled spores (fig. 21), borne in more or less flasked-shaped receptacles beneath the surface. When the surface of the potato is ruptured, these spore bodies are set free. The spores are at first colorless and one celled. The Java black-rot begins usually at the end and grows very slowly, requiring under normal storage conditions from 4 to 8 weeks to completely destroy a potato.

CHARCOAL ROT.

A rot of less economic importance is occasionally found in the storage houses throughout the country, which likewise produces a black decay. This form of rot differs from others of a similar appearance by the production by the fungus of minute spherical resting bodies throughout the potato, rarely on the surface. These bodies are coal black and stand mostly separated from each other. If the surface of the potato be carefully opened, these bodies can be seen by the naked eye buried in the tissue. Some shrinking and drying of the potato follow an invasion of this fungus. The total loss to the crop that might be attributed to this disease is comparatively small. It is caused by the fungus *Sclerotium bataticola*.

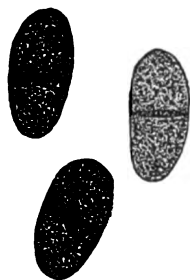


FIG. 21.—The dark 2-celled spores of the Java black-rot fungus.

CONTROL OF STORAGE ROTS.

The United States could and would produce many more sweet potatoes if they could be marketed at a fair profit. One of the chief barriers to the extension of the industry is the inability of the farmers to keep the potatoes in storage so that they can be placed on the market in the winter, when prices are good. As a result most of the potatoes in the South are consumed locally and placed on the market at digging time, when prices are low. Consequently, few sweet potatoes go on the northern markets in the winter, and even in the South where they are grown they can not be obtained with any degree of certainty at that season of the year. It is believed that if storage methods and principles were better understood, more potatoes would be available for winter use and disposed of at a good price.

The success of the industry, however, does not depend on successful storage methods alone. It is a well-known fact that there are several serious field diseases of the sweet potato, the best known of which are black-rot, stem-rot, and foot-rot. The storage of black-rot potatoes must necessarily result in heavy loss, since the disease spreads rapidly throughout the bins. Stem-rot, on the other hand, does not produce any marked decay in storage, but it may open the way for storage-rot organisms to enter the potato. It therefore becomes imperative that

the elimination of the field diseases must be coupled with a well-regulated system of storage.

Great care should be exercised in handling sweet potatoes not to bruise them any more than necessary. The bruises made by rough handling open the way for storage-rot organisms to enter. A farmer would never think of handling apples, oranges, or any of the fruits in the way that sweet potatoes are handled, and yet a barrel of good sweet potatoes will bring as much on the market, and often more, than a barrel of good apples, and sweet potatoes bruise even more readily than apples. It is likely that if sweet potatoes were handled with the same care and intelligence as apples little difficulty would be experienced in keeping them in storage.

After the potatoes are well dried in the field they should be carefully laid in an open crate holding about a bushel and hauled to the storage house. They should not be poured out of this crate into a bin, but stored in the crate itself. The use of crates permits the free circulation of air among the potatoes, a condition which can not be obtained if they are piled in a bin. The crate has an added advantage in that as many potatoes can be taken out for the market during the winter as are desired without disturbing the remainder. Sweet potatoes will not stand frequent handling, and for that reason it is unwise to disturb a pile or bin unless they are all marketed at the same time. The use of crates would eliminate this danger.

DIGGING AND HANDLING.

Potatoes intended for storage should be dug as late in the fall as is consistent with weather conditions. This is usually just preceding frost. Frozen potatoes will not keep well, and it is likely that a heavy frost will injure them to some extent. It is advisable, too, after a heavy frost to cut the vines at once and dig. It is believed that warm, dry, sunny weather preceding a frost is better for all concerned than a period a little later in the season following a frost. To wait too long may mean that in order to avoid freezes the potatoes must be dug during bad weather. After digging, the potatoes should be allowed to dry as long in the sun as is consistent with weather conditions and farm operations. On a very hot day, however, it would be desirable to hurry the potatoes to the shade after their surfaces have been dried in the sun.

THE STORAGE HOUSE AND ITS MANAGEMENT.

While sweet potatoes sometimes keep well when stored in banks with hay and dirt thrown over them, this system is not as reliable as a storage house. For full details on storing and marketing sweet potatoes, the reader is referred to Farmers' Bulletin 548 of the

United States Department of Agriculture. During the digging period and for 10 days or two weeks thereafter, the temperature of the house should be maintained at about 80° to 85° F. This will assist in curing the potatoes and driving off surplus moisture. Ventilators should be so arranged and manipulated that the moisture given off by the potatoes will be carried out of the house. At the end of about two weeks at a temperature of 80° to 85° F. the temperature should be gradually lowered to about 50° to 55° F., and maintained there through the storage period. During the winter the house should be watched as regards temperature and moisture. If there is any moisture accumulating, it should be gotten rid of by opening the ventilators at the top and admitting dry air from below. This should be done on a dry day when the outside temperature is about the same as that of the storage house. It must not be forgotten that the essentials in the management of the storage house are to keep it dry and maintain the temperature as near 50° to 55° F. as possible.

In the fall, just before the sweet potatoes are put in storage, the storage house or cellar should be thoroughly disinfected, in order to get rid of the numerous storage-rot germs left there from the previous crop. There are several efficacious methods that may be employed. The house may be sprayed with a solution made by dissolving 1 pound of copper sulphate in 25 gallons of water or with a solution of formaldehyde made by mixing 1 pint of formalin (40 per cent) in 30 gallons of water. In about 24 hours the house should be sprayed a second time. Similar results may be obtained by white-washing the storage house or cellar, or, better yet, by making up a barrel of winter strength lime-sulphur solution, 15 pounds of sulphur, boiled until dissolved with $7\frac{1}{2}$ pounds of stone lime, and then the whitewash added to the mixture. A second coat of whitewash will not be necessary.

UNITED STATES DEPARTMENT OF AGRICULTURE



FARMERS' BULLETIN



WASHINGTON, D. C.

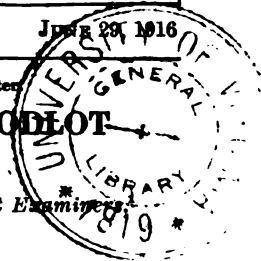
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JUNE 29, 1916

Contribution from the Forest Service, Henry S. Graves, Forester

MEASURING AND MARKETING WOODLOT PRODUCTS.

By WILBUR R. MATTOON and WILLIAM B. BARROWS, *Forest Examiners*



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AIM.

Lack of familiarity with the business of timber selling usually puts the owner of a small woodland at a disadvantage, and in many regions material from the woodlot is sold for considerably less than its real value. The loss to the farmers is, in the aggregate, very large. In order to stop this loss, it is necessary that the farmer inform himself about the different kinds and grades of woodlot products, the methods of estimating and measuring them and ascertaining their value, the methods of selling, the markets, and the current market prices. Especially does he need reliable information about the amount and real value of his standing timber and the location of good markets. It is the aim of this bulletin to assist woodlot owners in getting information of this kind, so that they may market their woodlot products at fair prices.²

PRINCIPAL WOODLOT PRODUCTS.

LOGS.

Many wood-manufacturing industries obtain their raw material in the form of logs and bolts. Logs may be sold by sizes and grades

¹ Mr. Barrows's contribution deals with the subject of measuring, and is found on pp. 12 to 26, inclusive.

² Information in regard to the best methods of improving and growing timber in the farm woodlot is given in Farmers' Bulletin 711, "The Care and Improvement of the Woodlot."

or without classification by the lot. Selling "log run" is simple and direct, but offers good opportunity for speculation, usually to the advantage of the buyer, whose knowledge of timber is better than that of the seller. The method is advisable only after the owner has made a careful estimate of the amount and quality of the standing timber. Selling by sizes and grades, when these are defined in the contract, often results in larger money returns.

The quality of a log depends upon its dimensions and grade. Logs are inspected for the number and character of standard defects, which determine the grade, and are measured by taking the length and the average diameter at the small end. Large logs are more valuable than small ones of the same grade.

For example: In one market medium-grade 10-foot red-oak logs from 16 to 30 inches in diameter were worth \$19 per 1,000 feet; logs from 31 to 36 inches in diameter, \$23; and logs 37 inches and over in diameter, \$25. Logs with only slight defects or none were worth from \$6 to \$10 more, and logs with more defects were worth from \$3 to \$5 less than these prices.

GRADING.

The grade of a log depends upon the number and character of its defects. Among those recognized by the lumberman as standard are knots, rot, shakes, season checks, frost cracks, sun scald, fire scars, seams, wormholes, stain, spiral or crooked grain, cat faces, and crook in the log. Standard grading rules may be applied to all species collectively for the purposes of rough grading, but usually there are different specifications for different species. In general, grading is more common and the number of grades larger for the more valuable woods than for the inferior kinds of timber.

Unfortunately, there are no standard specifications for log grades. Rough local grades are in quite general use, but are not defined. They are of only limited aid to the seller because they are subject to differences of interpretation.

The adoption by some acknowledged authority and the recognition throughout a State or region of a few standard grades and sizes for logs of various kinds of trees would be of very great assistance in the marketing of woodlot timber. It would afford common ground on which buyer and seller might meet.¹ Some of the various lumber manufacturers' associations publish specifications for the grading of logs of the more important trees, copies of which are available upon application to the secretaries.

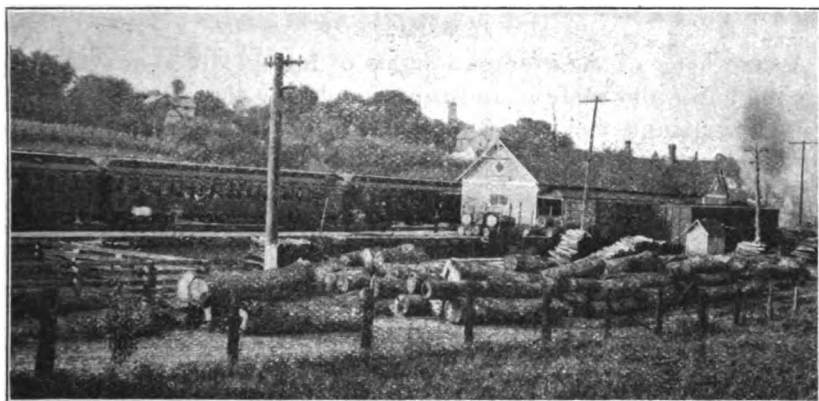
Three rough grades are in use in many parts of the eastern United States. These are commonly known as "No. 1," "No. 2," and

¹ There is an opportunity for the various State forestry organizations in cooperation with lumber associations to work for the adoption of standard log grades in their States.

"No. 3," or as "good," "common," and "cull." In some regions a No. 1 log must cut its full scale in No. 1 common lumber or better, a No. 2 log must saw out two-thirds of the scale in No. 1 common or better, and a No. 3 log must cut one-half of its scale in No. 2 common with a little of the better grades. Two small limb knots are allowed in a No. 1 log, but two large knots or body knots make it a No. 2 grade, and if they occur at each end, a cull log. Exterior checking and shallow cat faces are not defects, since they go into the slab only.

In practice, the second grade sells for about two-thirds and the third grade for about one-half, or less, the price of the first grade. In some localities only two grades are used.

Other forms of grading used in different regions are: Grade No. 1, logs 10 inches and over in diameter with surface and ends clear



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FIG. 1.—High-grade logs from farm woodlots, such as these, can be profitably shipped by rail to outside markets. (White oak, yellow poplar, ash, and basswood.)

of defect, and sap wood bright in color; grade No. 2, logs having not more than three standard defects, or slightly wormy; and grade No. 3, logs falling below the No. 2 grade, chiefly because of worm and rot defects.¹

The veneer industry secures most of its raw product in the form of logs and flitches (large-sized pieces sawed from logs). Both are sold by the thousand board feet. The specifications are not uniform. The essential points refer to the species, the size of the logs, and the grade of the wood. Diameters for hardwoods run mostly from 14 inches up, and lengths from 6 to 16 feet. Logs must be cut 4 inches over the specified length to allow for trimming. The rules for yellow poplar given below² will serve as an illustration of the manner of grading, although to make the specifications complete the defects would have to be defined. Very few logs meet the requirements of

¹ The National Hardwood Manufacturers' Association of the United States, Cincinnati, Ohio, issues grading specifications for grades of logs for several kinds of wood.

² Specifications from forthcoming bulletin, "The Veneer Industry in the United States."

the No. 1 grade, and the buyer exercises discretion in departing more or less from this standard.

No. 1 yellow poplar logs must be straight-grained and free from knots, cat faces, wind-shakes, rotten center, double hearts, hearts grown to one side, and other defects. These specifications apply to logs up to and including 12 feet in length; logs 14 feet and 16 feet long may have one defect not over 6 inches in diameter; logs over 16 feet long may have two defects not over 6 inches in diameter; also a log may have a hole in the center not greater than one-fifth of the diameter of the log.

No. 2 yellow poplar logs must be the same as No. 1, except they may have defects not to exceed one-third of the circumference.

Cull logs are those that grade poorer than No. 2.

Logs will command full price when freshly cut, but logs that have suffered from exposure are not desirable under any circumstances and will at no time bring any but low prices. Diameters will be taken the small way across the small end and the contents scaled by the log rule agreed upon.

WEIGHT.

A knowledge of the average weights of logs of different species in a green and a dry state is useful in calculating the cost of handling the material and making shipments by rail. Table 1 shows these weights for logs, bolts, cordwood, and rough lumber.

TABLE 1.—*Approximate weights of various woodlot products.¹*

Species.	Lumber (per 1,000 board feet).			Logs (per 1,000 board feet log scale, Doyle rule). ¹						Cordwood, bolts, butts, etc., per cord. ²	
	1 inch thick.		Rough ³ (classed as 1 inch thick).	Diameter inside bark at small end.							
	Green.	Air dry.		12 inches.		18 inches.		24 inches.			
				Green.	Dry.	Green.	Dry.	Green.	Dry.	(Green.	Dry.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Ash, white	4,000	3,500	3,500	11,100	9,700	7,700	6,800	6,600	5,700	4,300	3,800
Basswood	3,400	2,100	2,600	9,500	5,900	6,600	4,100	5,600	3,500	3,700	2,300
Beech	4,600	3,600	4,000	12,700	10,100	8,900	7,000	7,500	6,000	5,000	3,900
Birch, yellow	4,800	3,700	4,000	13,200	10,300	9,200	7,200	7,800	6,100	5,100	4,000
Cherry, black	3,800	3,000	4,000	10,500	8,300	7,300	5,800	6,200	4,900	4,100	3,200
Chestnut	4,600	2,500	2,800	12,600	7,000	8,800	4,900	7,500	4,100	4,900	2,700
Cottonwood	3,600	2,200	2,800	10,700	6,300	7,500	4,400	6,300	3,700	4,200	2,500
Elm, soft	4,000	2,900	3,200	11,200	8,000	7,800	5,600	6,600	4,700	4,400	3,100
Elm, rock	4,600	3,300	3,800	12,600	9,200	8,800	6,400	7,500	5,500	4,900	3,600
Gum, red	3,900	2,800	3,300	10,700	7,800	7,500	5,500	6,300	4,600	4,200	3,100
Hickory	5,200	4,300	5,000	14,700	11,900	10,300	8,300	8,700	7,000	5,700	4,600
Locust, black	4,800	4,100	.....	13,300	11,400	9,300	7,900	7,900	6,700	5,200	4,400
Maple, sugar	4,700	3,600	4,000	12,900	10,000	9,000	7,000	7,600	5,900	5,000	3,900
Maple, red	4,300	3,000	3,000	11,900	8,200	8,300	5,700	7,100	4,900	4,700	3,200
Maple, silver	3,800	2,800	3,000	10,500	7,800	7,700	5,400	6,200	4,600	4,100	3,000
Oak, red	5,400	3,600	3,900	14,800	10,100	10,300	7,000	8,800	6,000	5,800	3,900
Oak, white	5,200	4,000	3,900	14,400	11,000	10,000	7,700	8,500	6,500	5,600	4,300
Sycamore	4,300	3,000	3,200	12,000	8,300	8,400	5,800	7,100	4,900	4,700	3,200
Yellow poplar	3,200	2,400	2,800	8,800	6,500	6,100	4,500	5,200	3,900	3,400	2,500
Tupelo	5,500	3,000	.....	15,100	8,400	10,500	5,900	8,900	5,000	5,900	3,300
Walnut	4,300	3,000	4,000	11,900	8,200	8,300	5,700	7,100	4,900	4,700	3,200
Willow	4,300	2,100	.....	11,800	5,900	8,200	4,100	7,000	3,500	4,600	2,300

¹ These weights and those in Tables 2, 3, and 5 are not the shipping weights prescribed by any railroad or any State railroad commission.

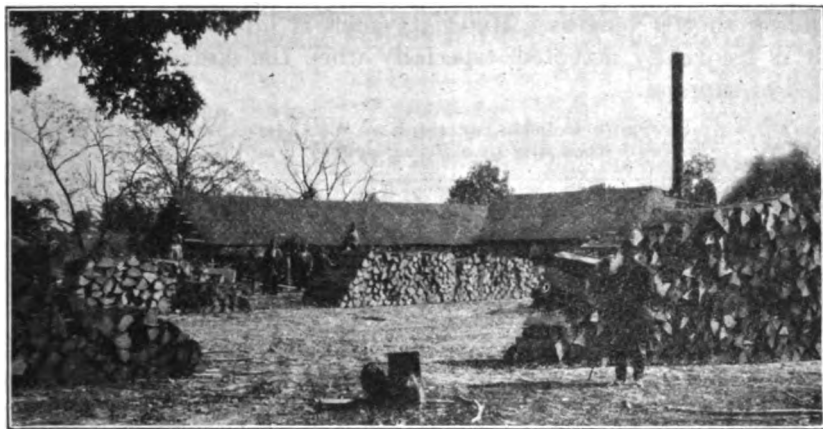
² Weights of rough lumber in this column are official standard weights of the Hardwood Manufacturers Association of the United States. Rough lumber is usually cut more than 1 inch thick, to allow for shrinkage in seasoning.

³ Weights of logs and cordwood computed from A. K. Armstrong's weights of hardwood per cubic foot (90 cubic feet per cord).

⁴ Figures for tupelo may be used for black gum or pepperidge.

BOLTS AND BILLETS.

Bolts are short sections of logs. Billets are obtained by halving, quartering, or otherwise splitting or sawing bolts lengthwise. The split pieces of cordwood are good examples of billets. Sawed billets include flitches, squares, and other forms of partly manufactured products. Because splitting causes a great deal of waste, it has been largely superseded by sawing. For example, a cord of average-sized hickory bolts that will yield only about 700 rived spoke billets may be sawed into 900 billets. Bolts and billets are used for cooperage, wood pulp, excelsior, wooden ware (pails and tubs), handles, vehicle parts, some agricultural implements, fruit and vegetable packages, athletic goods, pencils, etc.



F-1 WRM

FIG. 2.—Stave bolts and billets of white and red oak, cut 36 inches to make 34-inch staves.

Cooperage plants consume very large quantities of material which comes from the woods in the form of bolts and billets. Wood pulp is made from pieces of many shapes and sizes. Much of the raw material used by the handle and wagon-wheel industries is ash and hickory bolts and billets, the hickory going into ax and hammer handles and wagon spokes and the ash into hoe, rake, and shovel handles.

Bolts are measured and sold by the cord, by linear feet, and by board feet. If they are 12 inches or over in diameter, they are usually sold by board measure. Billets are frequently sold by the piece or count, particularly if sawed and of uniform size, or are stacked and measured in cords, either standard or short cords of specified width. Table 2 gives the weight per stack of bolts of different kinds of wood and of different lengths and diameters.

The grades and specifications used in slack cooperage are very numerous, but the forms and qualities for tight-cooperage stock, including staves, hoops, and heading, are much restricted. Specifications refer to the species, length, width, thickness, and soundness of

timber. The white oaks are practically the only woods used in the manufacture of tight cooperage; but many different kinds of wood may be made into barrels for flour, sugar, vegetables, salt, cement, lime, etc. One representative specification for stave bolts for tight cooperage reads:

Stave bolts must be made from sound white or post oak; must measure 4 inches and up from inside of sap to heart edge; must be free from worm holes, season checks, knots, shake, and dote; and must be full 37 inches long, sawed square on end to equalize 36 inches.¹

For handle stock, the specifications call for second growth, straight, sound bolts or billets of specified length. Ash bolts for farm-tool handles are mostly from 30 to 60 inches in length. For hammer, ax, and other handles, hickory is bought under similar conditions but including shorter lengths. Material which is inferior to that called for is frequently accepted, especially when the users are in urgent need of supplies.

TABLE 2.—*Approximate weights per stack of bolts, green and dry, of different kinds of wood and of different lengths and diameters.*

Species.	Diam-eter.	Length of bolt—feet.								Weight per cubic foot.
		2½	3	3½	4	4½	5	5½	6	
		(½ cord.)	(½ cord.)	(¾ cord.)	(1 cord.)	(1½ cords.)	(1½ cords.)	(1½ cords.)	(1½ cords.)	
		Weight per stack—pounds.								
Ash, white	Inches.									
Green.....	6	2,600	3,200	3,700	4,200	4,800	5,300	5,800	6,300	49.1
	8	2,800	3,300	3,900	4,400	5,000	5,500	6,100	6,600	
	12	2,900	3,400	4,000	4,600	5,100	5,700	6,300	6,900	
Air dry.....	6	2,300	2,800	3,200	3,700	4,200	4,600	5,100	5,600	42.1
	8	2,400	2,900	3,400	3,900	4,400	4,800	5,300	5,800	
	12	2,500	3,000	3,500	4,000	4,500	5,000	5,500	6,000	
Basswood:										
Green.....	6	2,300	2,700	3,200	3,600	4,100	4,500	5,000	5,500	41.3
	8	2,400	2,800	3,300	3,800	4,300	4,700	5,200	5,700	
	12	2,500	2,900	3,400	3,900	4,400	4,900	5,400	5,900	
Air dry.....	6	1,400	1,700	2,000	2,300	2,600	2,800	3,100	3,400	25.3
	8	1,500	1,800	2,100	2,400	2,700	3,000	3,300	3,600	
	12	1,500	1,800	2,100	2,500	2,800	3,100	3,400	3,700	
Cottonwood:										
Green.....	6	2,600	3,100	3,600	4,100	4,600	5,100	5,600	6,100	46.5
	8	2,700	3,200	3,700	4,300	4,800	5,300	5,900	6,400	
	12	2,800	3,300	3,900	4,400	5,000	5,500	6,100	6,600	
Air dry.....	6	1,500	1,800	2,100	2,400	2,700	3,000	3,300	3,600	27.3
	8	1,600	1,900	2,200	2,500	2,800	3,100	3,500	3,800	
	12	1,600	1,900	2,300	2,600	2,900	3,200	3,600	3,900	
Elm, rock and white:										
Green.....	6	2,700	3,200	3,700	4,300	4,800	5,300	5,900	6,400	48.6
	8	2,800	3,400	3,900	4,500	5,000	5,600	6,100	6,700	
	12	2,900	3,500	4,000	4,600	5,200	5,800	6,300	6,900	
Air dry.....	6	1,900	2,300	2,700	3,000	3,400	3,800	4,200	4,600	34.6
	8	2,000	2,400	2,800	3,200	3,600	4,000	4,400	4,800	
	12	2,100	2,500	2,900	3,300	3,700	4,100	4,500	4,900	
Hickory, shagbark:										
Green.....	6	3,500	4,200	4,900	5,600	6,300	7,000	7,700	8,400	63.3
	8	3,700	4,400	5,100	5,900	6,600	7,300	8,100	8,800	
	12	3,800	4,500	5,300	6,100	6,800	7,600	8,300	9,100	
Air dry.....	6	2,800	3,400	4,000	4,500	5,100	5,700	6,200	6,800	51.5
	8	3,000	3,600	4,100	4,700	5,300	5,900	6,500	7,100	
	12	3,100	3,700	4,300	4,900	5,500	6,100	6,700	7,300	

Stacks are 4 feet in height by 8 feet long, made up of bolts of different sizes. Bolts 4 feet long make a standard cord, while shorter lengths make "short cords," and longer lengths a cord and over.

¹ Tentative specifications by the Forest Service for sales on National Forests in Arkansas.

POLES.

Chestnut and eastern white cedar furnish the bulk of the eastern pole timber. Specifications for chestnut poles generally require material to be of the best quality second-growth live chestnut (cut during the winter), of specified dimensions, butt cut, squared at both ends, reasonably straight, well proportioned from tip to butt, peeled, and with knots trimmed close. Defects looked for in inspection are crookedness, split tops and butts, sap and butt rot, checks, and shakes. Poles are assigned to two or three classes, according to their length, top circumference, and circumference measured at 6 feet from the butt. Poles of the 40-foot class, for example, are required by one representative pole company to be 24 inches in top circumference¹ and 48 inches in basal circumference, while second-class poles of the same length measure only 22 and 46 inches, respectively, at the two points.

The dimensions shown in Table 3 for classes A, B, and C, with only slight modifications, are used by most telegraph and railroad companies and other purchasers of poles. The corresponding cubic contents and weights shown will be useful in making shipments. The figures are too low by from 10 to 20 per cent for full-bodied trees with small butt swell and likewise too high for trees with a marked basal swell.

As poles season they become lighter and in one year lose about 20 per cent of their weight when green. Table 4 shows the loss in weight in chestnut poles due to seasoning for monthly periods up to 15 months. To determine the approximate weight of chestnut poles after partial seasoning, apply the percentage of loss in weight shown in Table 4 to the green weight in Table 3.

TABLE 3.—*Approximate weights of green chestnut poles of different sizes.*²

CLASS A.

Length.	Circumference.			Diameter.			Volume.	Weight. ³
	Top.	6 feet from butt.	Butt.	Top.	6 feet from butt.	Butt.		
<i>Feet.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Cu. ft.</i>	<i>Pounds.</i>
30.....	24	40	43	7.6	12.7	13.7	20.0	1,100
35.....	24	43	46	7.6	13.7	14.6	26.0	1,430
40.....	24	45	48	7.6	14.3	15.3	31.5	1,730
45.....	24	48	51	7.6	15.3	16.2	39.1	2,150
50.....	24	51	54	7.6	16.2	17.2	47.5	2,610
55.....	22	54	58	7.0	17.2	18.5	56.5	3,110
60.....	22	57	61	7.0	18.1	19.4	67.0	3,680
65.....	22	60	64	7.0	19.1	20.4	79.4	4,370
70.....	22	63	67	7.0	20.1	21.3	93.1	5,120
75.....	22	66	70	7.0	21.0	22.3	107.6	5,920
80.....	22	70	74	7.0	22.3	23.6	127.4	7,010
85.....	22	73	78	7.0	23.2	24.8	145.4	8,000
90.....	22	76	81	7.0	24.2	25.8	165.9	9,120

¹ Equivalent to 7.6 inches in diameter.² Sizes conform to standard specifications of the National Electric Light Association.³ Based on a weight of 55 pounds per cubic foot.

TABLE 3.—*Approximate weights of green chestnut poles of different sizes—Continued.*

CLASS B.

Length.	Circumference.			Diameter.			Volume.	Weight.
	Top.	6 feet from butt.	Butt.	Top.	6 feet from butt.	Butt.		
<i>Feet.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Cu. ft.</i>	<i>Pounds.</i>
30.....	22	36	38	7.0	11.5	12.1	16.5	910
35.....	22	40	42	7.0	12.7	13.4	22.2	1,220
40.....	22	43	46	7.0	13.7	14.6	28.5	1,570
45.....	22	47	50	7.0	15.0	15.9	36.9	2,030
50.....	22	50	53	7.0	16.9	16.9	45.0	2,480
55.....	22	53	57	7.0	18.9	18.1	54.7	3,010
60.....	22	56	60	7.0	17.8	19.1	65.1	3,580
65.....	22	59	63	7.0	18.8	20.1	77.2	4,250
70.....	22	62	67	7.0	19.7	21.3	90.1	4,980
75.....	22	65	70	7.0	20.7	22.3	104.9	5,770
80.....	22	69	74	7.0	22.0	23.6	124.6	6,850
85.....	22	72	78	7.0	22.9	24.8	142.1	7,820
90.....	22	75	81	7.0	23.9	25.8	162.2	8,920

CLASS C.

30.....	20	33	35	6.4	10.5	11.1	13.7	750
35.....	20	36	38	6.4	11.5	12.1	18.3	1,010
40.....	20	40	42	6.4	12.7	13.4	24.4	1,240
45.....	20	43	46	6.4	13.7	14.6	30.9	1,700
50.....	20	46	49	6.4	14.6	15.6	38.0	2,080
55.....	20	49	53	6.4	15.6	16.9	46.7	2,570

TABLE 4.—*Weights of chestnut poles during seasoning, expressed in per cent of green weight, for poles cut in the different seasons.¹*

Duration of seasoning.	Season when cut.				Duration of seasoning.	Season when cut.			
	Spring.	Summer.	Autumn.	Winter.		Spring.	Summer.	Autumn.	Winter.
<i>Months.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Months.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
0.....	100	100	100	100	8.....	82	85	85	82
1.....	94	93	96	98	9.....	82	85	84	81
2.....	90	89	94	95	10.....	82	84	83	80
3.....	87	83	93	93	11.....	82	83	82	79
4.....	86	87	92	90	12.....	81	82	81	79
5.....	85	87	91	88	13.....	80	81	80	79
6.....	84	86	89	85	14.....	80	80	79	78
7.....	83	86	87	84	15.....	79	79	79	78

¹ Based on weights reported for 600 poles cut in Thorndale, Pa. (See Forest Service Circular 103, Seasoning of Telephone and Telegraph Poles, p. 11; also, Bulletin 84, Preservative Treatment of Poles, p. 51.) Apparent irregularities, like the percentages shown for the eighth to tenth months in the column headed "Spring" and the fifteenth month under "Autumn" are seemingly due to local conditions in relative humidity of the atmosphere.

PILING.

The classification or grading of piling depends largely upon its use, whether in fresh water, salt water, or on land, and upon its form and size. Very often the kind of wood is not specified, and the requirements refer to straightness, length, and butt diameter measured 3 feet from the end. Specifications are sometimes rather brief and simple, and piling then becomes one of the easiest classes of timber to grade for the market. Important construction work often calls for specifications more or less similar to the following.¹

All piling shall be cut from sound, live trees of slow growth and firm grain, and free from ring heart, wind-shakes, decay, large or unsound knots, or any

¹ Based upon standard specifications of The Panama Canal.

other defects that will impair their strength or durability. The trees shall be butt cut, above the ground swell, and shall taper uniformly from butt to tip. Piles shall be so straight that the line joining the centers of the ends will fall entirely within the pile, and that in the opinion of the inspector they can be subjected to hard driving without injury. No short or reverse bends will be allowed. Bark shall be peeled from the entire length of all piles, and all knots shall be trimmed close. No pile will be accepted with a top measuring less than 6 inches diameter. The allowable diameter shall be as follows: Butts of piles under 30 feet in length to be from 12 to 16 inches, and butts of piles from 30 to 50 feet in length to be from 12 to 18 inches.

Piling is sold at a stated price per linear foot for specified dimensions and kinds of wood. The price increases rapidly with increase in length and in desirability of form or taper. Handling and transportation costs are large because of the heavy weight of sticks of this size. Table 5 shows the approximate weight of piling of different sizes and of different kinds of wood in both green and dry condition.

TABLE 5.—*Approximate weights of piling of different sizes, green and dry, for different kinds of wood, also weight per cubic foot of each.*

Length.	White oak.		Black oak.		Sugar maple.	
	Green.	Air-dry.	Green.	Air-dry.	Green.	Air-dry.
	Weight—pounds.					
<i>Feet.</i>						
20.....	610	470	610	440	550	430
25.....	770	590	770	550	690	530
30.....	920	700	920	660	820	640
35.....	1,080	820	1,080	770	960	730
40.....	1,580	1,200	1,590	1,140	1,410	1,100
45.....	1,780	1,360	1,790	1,280	1,590	1,240
50.....	1,980	1,500	1,990	1,420	1,770	1,370
	Weights per cubic foot used above—pounds.					
	62.7	45.0	62.5	47.6	55.9	43.4

Length.	Chestnut.		White elm.		Black gum.		Increase with top diameter of 8".
	Green.	Air-dry.	Green.	Air-dry.	Green.	Air-dry.	
	Weight—pounds.						
<i>Feet.</i>							<i>Per cent.</i>
20.....	540	300	480	340	440	350	15.3
25.....	670	370	600	430	550	450	15.4
30.....	810	440	710	510	660	530	15.6
35.....	940	520	840	600	770	620	15.7
40.....	1,390	760	1,230	880	1,130	920	12.3
45.....	1,560	860	1,390	990	1,270	1,030	11.9
50.....	1,730	950	1,540	1,090	1,410	1,140	12.3
	Weights per cubic foot used above—pounds.						
	54.8	30.2	48.6	34.6	44.7	36.2	.....

Top diameter, 6 inches; butt diameter, 12 inches for piling 20 to 35 feet inclusive; 14 inches for piling 40 to 50 feet inclusive.

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CROSSTIES.

The specifications for railroad ties in most cases are for sound timber of good quality, stripped of bark, and free from imperfections that would impair their strength and durability, such as shakes and loose or decayed knots. The ties must be sawed or hewed smooth on two parallel faces, and the ends must be cut square. Pole ties are made of round timber on which are hewed two parallel faces; square ties are hewed or sawed into rectangular shape.

Ties are classified according to the species of wood, on the basis of its wearing and lasting qualities and need for preservative treatment. They are further classified into two or more grades, depending upon their thickness and width of face.

Class A ties consist of the more durable woods, and generally include white oaks, black walnut, black cherry, chestnut, sassafras, and red mulberry. Class B is made up of such woods as red oaks, beech, hickories, maples, sycamores, black gum, elms, and several others of the less durable woods requiring preservative treatment before using. Standard ties are either 8 or 8½ feet in length. No. 1 ties, for example, on some railroad schedules, if they are sawed ties, must be 7 inches thick by 8 inches wide on the face; if hewed on all sides or sawed on the faces, they must be 7 inches thick and not less than 7 inches nor more than 12 inches wide at any place on the face. No. 2 ties are between 6 and 9 inches thick and not less than 6 inches wide on the face. Variations in length of 1 inch under or 2 inches over the specifications and in thickness of ¼ inch under or 1 inch over are allowed by many purchasers. Mine ties run from 3 to 6 feet in length and down to 4 by 6 inches in cross dimensions.

Prices are exceedingly variable in different parts of the country, depending upon the kind of wood, size, grade, and distance of the producing point from the larger trunk-line railroads. In middle Tennessee, for example, farmers receive from 40 to 50 cents for class A white oak ties of large size delivered along the track, while in Ohio a similar tie nets the farmer from 60 to 70 cents. Chestnut ties of the largest size bring about 70 cents each in New England.

MINE TIMBERS.

The kinds and forms of timbers in demand for mines are many, and, as a rule, many kinds of wood are usable. The principal forms of round or rough material, other than lumber, follow:

Mine props are round timbers used as main supports for the roof and sides of tunnels; in diameter they vary from 4 to 14 inches, and in length mostly from 3 to 12 feet. For chestnut, prices are from 1 to 2 cents per linear foot at the mines in Pennsylvania.

Lagging is round timber about 3 inches in diameter and 7 feet in length, used to fill in behind the props and caps to form the sides and roofing of the tunnels. Bars are extra long lagging. The mines in Pennsylvania pay about 3 cents apiece for lagging.

Caps are hewed or sawed pieces of timber of different sizes laid across the tops of pairs of props as a support for the roof lagging, which runs lengthwise of the tunnel.

Sills as foundation for props are from 8 to 14 inches in diameter. Although these are often of sawed material, square hewed timbers are much used.

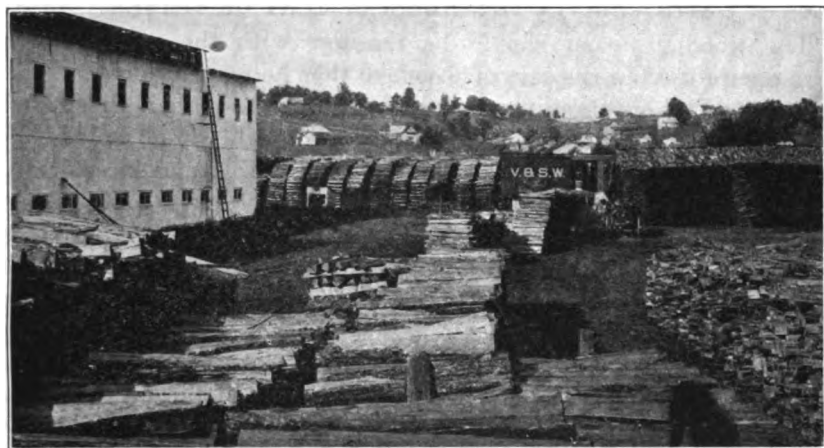
Mine ties, including tramroad, motor, and heading ties, are ordinary track ties, 4 inches on the face and varying in length mostly from 3 to 5 feet.

Rough lumber goes into mine rails, collar timbers, brattice or partition boards, stringers, and sills.

Prices for round or hewed timbers in the Pennsylvania coal regions range mostly from 1 to 4 cents per linear foot, depending upon diameter; the larger sizes, above 8 inches, are commonly sold by log scale at prices of from \$8 to \$14 per thousand board feet.

CORDWOOD.

Any kind of wood measured by the cord and in the form of either round or split sticks is called cordwood. Firewood is measured in



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FIG. 3.—Chestnut wood and chestnut-oak bark at an acid or extract plant. (The wood is worth from \$4 to \$5 per cord at the factory, and the bark from \$8 to \$10 per cord.)

standard cords, mostly of 4-foot lengths,¹ or short cords of stove wood and other material varying from 12 to 20 inches in length. Materials for distillation, extract wood, excelsior, pulp, handles, cooperage, and woodenware are frequently sold by the rick or cord. The lengths vary mostly from 22 inches for heading to 5 feet for extract and handle stock. Specifications, if given, refer to the kind of wood, length, average size of the pieces, whether split or round, general soundness, body or limbwood, and degree of dryness.

LUMBER.

Specifications for lumber deal with quality and size, in addition to kind of wood. Very many wood-manufacturing concerns are now buying their rough stock lumber by grade and dimension where formerly they took the "mill-run" product, or the lumber as it came

¹ For size and contents of standard cord, see p. 16.

from the saw without sorting and classifying. It is not the purpose of this bulletin to take up in detail the subject of grading, because it is rather complicated. Four grades of rough lumber are generally recognized, as follows: First and seconds, a general term for the highest grade; No. 1 common; No. 2 common; and No. 3 common, or culls. The basis for grading is the quality of the lumber as determined by the number and size of standard defects, such as knots, shake, wormholes, dote, and stain; also by the width of the piece. As lumber becomes more valuable, particularly the finished product, the number of grades greatly increases. In the lumber market grades have been more or less standardized for each species by the various manufacturing associations, from which copies of grading rules may be obtained at a few cents each.

UNITS USED IN THE MEASUREMENT OF TIMBER.

The woodlot owner should be familiar with the various units of measure used in the sale of wood, so that he may be able to make an estimate of his standing trees and to measure or scale the timber after it is cut. In regard to his ordinary field crops he is well informed. He knows that hay is sold by the ton, and he can estimate how many tons the grass on a certain field will produce; or, if he has the hay in a barn, he can calculate how many tons there are in a mow of a certain size. He can estimate the amount of his corn or wheat in a similar manner, because he deals with these crops every year. Timber, however, may be sold from a woodlot only once in a generation. It is natural that the farmer, not being as familiar with timber measurements as he is with those relating to other crops, should rely on the estimates of the buyer, who, obviously, is careful to see that his own interests are protected. What the farmer needs, then, is a guide to which he can refer when he is considering selling some of the products of his woodlot.

Wood is sold in a number of different units. The amount may be measured in board feet, in cords, or it may be sold by the piece in the form of ties, poles, posts, or other products. In the latter case it is comparatively easy to determine, if one has the specifications, just which pieces of wood fulfill the requirements; but when logs are sold in the round it is not easy to determine how many board feet are contained in each log.

To enable one to estimate the number of board feet in logs of different sizes log rules are used. A log rule is a statement, either in the form of a printed table or burnt upon a measuring stick, of the estimated number of board feet of lumber which can be sawed from logs of various lengths and diameters. There are over 40 different log rules in use, and the values assigned to logs of the same size by different rules vary considerably. In some States one rule has been made the legal rule and must be used when no log

rule is specified in contracts for selling logs, although if buyer and seller can agree to use a different rule no objection is made. In other States, however, it is illegal to use any other rule than the statute rule.

The number of board feet in a log 12 inches in diameter by 16 feet in length, scaled by the different rules, ranges from 62 to 112 board feet. This is a large variation. If the seller had the choice of a rule for measuring logs of this size, he would naturally select the one which gave a large value; and the buyer would, of course, prefer the rule which gave a small value.

TABLE 6.—*Comparison of log rules.*

[The values given are for 16-foot logs only.]

Top diameter of log inside bark.	Scribner.		Doyle.	Doyle and Scrib- ner.	Holland or Maine.	Blodgett or New Hampshire.	Humphrey or Ver- mont.	Bangor.	Cumberland River.	Square of three- fourths.	Herring.	Champlain.	Tiemann.
	Scribner.	Decimal C.											
	Contents—(board feet).												
Inches.	(10)	(10)			(3)	13	11	(6)	8	12	(6)	8	9
4.....	(10)	(10)	1	1	(11)	19	16	(12)	12	19	(12)	14	15
5.....	(13)	(10)											
6.....	18	20	4	4	20	26	24	23	17	27	(19)	22	23
7.....	24	30	9	9	31	35	32	27	23	37	(26)	32	32
8.....	32	30	16	16	44	43	43	41	31	48	34	43	43
9.....	42	40	25	25	52	54	53	54	39	61	43	56	55
10.....	54	60	36	36	68	66	67	69	47	75	53	70	69
11.....	64	70	49	49	83	78	80	84	57	91	65	87	84
12.....	79	80	64	64	105	92	96	100	68	108	77	105	101
13.....	97	100	81	81	120	106	112	118	80	127	91	124	119
14.....	114	110	100	100	142	123	131	137	93	147	107	146	139
15.....	142	140	121	121	161	139	149	158	107	169	124	168	160
16.....	159	160	144	144	179	157	171	182	121	192	142	193	183
17.....	185	180	169	169	205	176	192	209	137	217	162	219	207
18.....	213	210	196	196	232	197	216	238	153	243	183	247	233
19.....	240	240	225	225	271	217	240	258	171	271	206	277	260
20.....	280	280	256	256	302	240	267	300	190	300	230	308	289
21.....	304	300	289	289	336	262	293	334	209	331	256	341	319
22.....	334	330	324	324	363	287	323	359	229	365	284	376	351
23.....	377	380	361	361	401	313	352	406	250	397	313	412	384
24.....	404	400	400	400	439	339	384	414	273	432	344	450	419
25.....	459	460	441	441	477	367	416	484	296	469	377	490	455
26.....	500	500	484	484	507	397	451	526	320	507	411	532	493
27.....	548	550	529	529	546	426	485	566	345	517	447	575	532
28.....	582	580	576	582	614	457	523	609	372	588	485	620	573
29.....	609	610	625	609	657	489	560	652	399	631	525	666	615
30.....	657	660	676	657	706	514	600	697	427	675	567	714	659
31.....	710	710	729	710	755	557	640	743	456	721	616	764	704
32.....	736	740	784	736	795	592	683	792	485	758	655	814	751
33.....	784	780	811	784	848	628	725	842	516	817	703	868	799
34.....	800	800	900	800	900	666	771	892	548	867	752	923	849
35.....	876	880	961	876	949	704	816	(950)	581	919	(800)	980	900
36.....	923	920	1,024	923	1,026	744	864	(1,000)	614	972	(850)	1,038	953
37.....	1,029	1,030	1,089	1,029	1,089	785	912	(1,050)	649	1,027	(910)	1,097	1,007
38.....	1,068	1,070	1,156	1,068	1,135	827	963	(1,110)	685	1,083	(960)	1,159	1,063
39.....	1,120	1,120	1,225	1,120	1,209	870	1,013	(1,170)	721	1,141	(1,020)	1,222	1,120
40.....	1,204	1,200	1,296	1,204	1,261	914	1,067	(1,220)	759	1,200	(1,080)	1,287	1,179

¹ The Tiemann rule is a good standard for purposes of comparison. It is not in common use, but gives the actual amount of lumber that can be slash sawed from average sound logs by a circular saw cutting a 4-inch kerf. This table shows that the Scribner rule underestimates the amount of lumber that can be sawed from small logs, but for those 20 inches and up it comes very close to the truth. The Doyle rule underestimates still further the contents of small logs, but overestimates those of large logs.

Comparison of a few log rules with the Tiemann rule.

Log rule.	For diameters of—				
	6 to 11 inches.	12 to 20 inches.	21 to 30 inches.	31 to 40 inches.	41 to 50 inches.
	Per cent of Tiemann rule.				
Tiemann.....	100	100	100	100	100
Champlain.....	101	106	108	109	109
Scribner.....	76	89	99	99	102
Doyle.....	45	80	98	107	113
Doyle-Scribner.....	45	80	97	99	102
New Hampshire.....	99	86	80	78	77
Maine.....	97	102	105	107	-----
Vermont.....	98	93	91	91	90
Bangor.....	97	101	106	105	-----
Cumberland River.....	70	66	65	64	64
Square of three-fourths.....	111	105	103	102	102

Great care should be taken in selecting the log rule. The Doyle rule in particular should be avoided by sellers, many of whose logs are of small diameters. A 6-inch 16-foot log scales only 4 board feet by the Doyle rule and an 8-inch log only 16 board feet.

Table 7 shows how the price per thousand board feet would have to vary with a number of different log rules in order to obtain the same price for any given piece of timber.

TABLE 7.—Table showing the price which would have to be obtained if 1,000 board feet of logs scaled by the Tiemann rule were scaled by various other rules, assuming a stumpage price of \$5 per 1,000 by the Tiemann rule.

Log rule.	For diameters of—				
	6 to 11 inches.	12 to 20 inches.	21 to 30 inches.	31 to 40 inches.	41 to 50 inches.
	Value of stumpage per 1,000 board feet.				
Tiemann.....	\$5.00	\$5.00	\$5.00	\$5.00	\$5.00
Champlain.....	4.95	4.72	4.63	4.59	4.59
Scribner.....	6.58	5.62	5.05	5.05	4.90
Doyle.....	11.11	6.25	5.10	4.67	4.42
Doyle-Scribner.....	11.11	6.25	5.15	5.05	4.90
New Hampshire.....	5.05	5.81	6.25	6.41	6.49
Maine.....	5.15	4.90	4.76	4.67	-----
Vermont.....	5.10	5.38	5.49	5.49	5.56
Bangor.....	5.15	4.95	4.72	4.76	-----
Cumberland River.....	7.14	7.58	7.69	7.81	7.81
Square of three-fourths.....	4.50	4.76	4.85	4.90	4.90

SCALING TIMBER.**BOARD FEET.**

Log lengths can be conveniently measured with a measuring stick 8 feet long. About 3 inches should be added to the nominal length of the log, so that the rough end may be trimmed at the mill. If more than 6 inches of extra length is left, however, carelessness in sawing the tree into logs is indicated. For scaling purposes the average diameter inside bark at the small end of the log is measured. Diame-

ters are rounded off to the nearest inch; that is, $7\frac{1}{2}$ would be considered 7 and $7\frac{3}{4}$ would be considered 8.

As soon as each log is scaled it should be marked with crayon, so that there will be no danger of scaling it again. If systematic scaling is to be done, it is desirable to use a special book for the purpose. Number each log in this case instead of marking it with a cross or other mark. When the log is scaled its number is written on the small end.

The scale book should be ruled off into groups of four columns, the first column for the number of the log, the second for its length, the third for its diameter, and the fourth for the number of board feet. Only one kind of timber should be entered on a page.

Form for ruling log scale book.

Log No.	Length.	Diameter.	Scale.	Log No.	Length.	Diameter.	Scale.
	<i>Feet.</i>	<i>Inches.</i>	<i>Bd. ft.</i>		<i>Feet.</i>	<i>Inches.</i>	<i>Bd. ft.</i>
1.....				10.....			
2.....				11.....			
3.....				12.....			
4.....				13.....			
5.....				14.....			
6.....				15.....			
7.....				16.....			
8.....				17.....			
9.....				Etc.....			

In case no scale stick is available the logs can be measured with an ordinary rule or yardstick and the board-foot values entered later. If the farmer expects to do much scaling he should provide himself with a scale stick. This consists of a strip of hickory about a quarter of an inch thick and an inch and a half wide and long enough to measure the largest logs which he will have to scale. It has burned on it the estimated board-foot contents of logs of different lengths and diameters. The contents of the logs can be read directly from the stick.

The scaling of sound logs is a comparatively simple matter. The question of how much to allow for defective logs is a point which requires years of experience to master; but ordinarily the farmer will not need to bother with the exact amount which should be deducted for decayed places in the logs.

LINEAR FEET.

Some forest products, such as piles and mining timbers, are sold by the linear foot. This simply means that timbers of certain diameters are sold for special purposes, the price depending on the number of linear feet in the stick or the total length of the stick. In this case it is only necessary to make sure that the diameters are those demanded by the specifications and that the lengths are

measured accurately. If it is desirable to keep a record of posts scaled by this method, they can be entered in a scaling book and given a number or not as the scaler may think necessary.

BY THE PIECE.

Railroad ties, posts, and some other products are usually sold by the piece. Certain maximum and minimum specifications or sizes are usually given, and then the sticks that come within these sizes are counted. These can be kept track of by numbering or marking with a crayon, one end of each tie as it is counted.

CORDWOOD.

Most farmers are familiar with the measurement of cordwood, but one or two points may be mentioned in this connection. It is customary to pile green cordwood 2 or 3 inches higher than the required 4 feet, in order to allow for shrinkage and settling as the wood dries. The average height and the average length of the pile should be measured in finding the number of cords.

The standard cord is 8 feet long 4 feet wide and 4 feet high. In some localities a long cord, 8 feet by 5 by 4 feet is used. Again, it often happens that sticks 4 feet long are sawed into 16-inch sticks and split fine enough for stove fuel. A running cord of this short wood, that is, a pile 8 feet long 4 feet high and 16 inches wide, equals one-third of a standard cord.

ESTIMATING STANDING TIMBER.

WITHOUT VOLUME TABLES.

Unless the woodlot is large it is desirable that every tree be estimated separately. The procedure is as follows:

A notebook or sheet of paper should be ruled off in squares of a convenient size somewhat as shown in the sample diagram below.

Species.	Butt log.			Second log.			Third log.			Total scale.
	Length.	Diameter.	Scale.	Length.	Diameter.	Scale.	Length.	Diameter.	Scale.	
	<i>Feet.</i>	<i>Inches.</i>	<i>Bd. ft.</i>	<i>Feet.</i>	<i>Inches.</i>	<i>Bd. ft.</i>	<i>Feet.</i>	<i>Inches.</i>	<i>Bd. ft.</i>	<i>Bd. ft.</i>
White oak....	16	16	.....	16	14	.....	16	11	.....	.....
Red oak.....	12	10	.....	12	8	.....			.....	.....
Sugar maple.	14	15	.....	12	12	.....			.....	.....
Beech.....	16	13	.....	16	16	.....	14	13	.....	.....
(Etc.).....			.....			.....			.....	.....
										
										

The estimator looks over the first tree and makes an estimate of how many logs can be cut out of it. Suppose the first tree is a white oak which forks at about 50 feet above the ground. Above that point the branches are too small or too crooked to be used for saw

logs. Allowing for the stump, then, the merchantable length of the tree is 48 feet, or three 16-foot logs. By looking at the tree carefully the estimator decides that the diameter, inside the bark, at the top of the first 16-foot log is 16 inches. Sixteen feet farther up the diameter appears to be 2 inches less, while at the top of the third log the diameter is 11 inches. These figures are entered in the proper spaces as shown in the diagram; and, later on, the number of board



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FIG. 4.—Measuring the contents of a woodlot and marking trees to be cut. (Marking is done by blazing the bark or by the use of white paint.)

feet in each of the three logs can be determined with the aid of the log rule, and the total board-foot contents of the tree found by adding the results.

In some cases it may be desirable to indicate in some way the grade of each log in the tree. The butt logs are generally of the highest grade and the top logs of the lowest. Where higher prices are paid for No. 1 logs, the difference may be enough to make it worth while to separate them from the No. 2 or No. 3 logs. The grade of the logs can be indicated in the upper right-hand corner of the square which is left for the board-foot contents of the log. When the final figures are added up only those which have a "1" in the upper right-hand corner will be added together to get the total amount of No. 1 logs; then are added the values which are indicated by No. 2, and so on.

After each tree is estimated, it should be marked in some way, so that there will be no danger of its being measured again. A piece

of chalk may be used or a small blaze can be made with a hatchet. This procedure is continued, the trees being taken as they come, but only those estimated which are big enough to be merchantable.

It is advisable to estimate the trees on an area of fairly uniform width, continuing across the woodlot until the other side is reached, then on the return trip the estimator can proceed on a fairly straight line. This makes it possible to be sure of getting all the trees without having to cover too much ground. The width of the first strip on which the timber is estimated will depend upon the convenience of the operator. With open timber the width can be greater than where the trees stand close together or where there is much underbrush. Under average conditions 50 feet would be a good width for the strip.

This method can also be used in estimating posts or poles or even cordwood. If posts are to be estimated the species or kind of wood, the length, and the top diameter of each are recorded. If the facts are put down in this form, the value of all the posts, or of any particular class, may be easily calculated. Table 8 will be useful in estimating roughly the quantity of material in cords, ties, poles, or sawlogs contained in trees of different diameters.

TABLE 8.—Quantity of material contained in trees of different sizes.¹

Diameter of tree (breast high).	Number of trees of each size required to yield—						Tie and pole prod- uct per tree.	
	1 cord.			1,000 feet of lumber.			Number of ties, hard- woods. ⁴	Length of pole, hard- woods. ⁵
	Hardwoods.		Soft- woods.	Hardwoods.		Soft- woods.		
	Northern. ²	Southern.		Northern. ²	Southern. ³			
<i>Inches.</i>								<i>Feet.</i>
2		170						
3		90						
4		50						
5	35	25						
6	20	17						
7	15	13	20					
8	11	9	13			25		
9	8	7	10	85	66	20		
10	6	6	8	45	33	15	1	
11	5	5	7	28	22	10	1	
12	4	4	6	19	13	8	2	25
13	3.5	3.4	4.5	14	11	7	2	25
14	3.0	3.0	3.7	11	9	6	3.3	30
15	2.5	2.5	3.0	8	7	5	3.3	35
16	2.0	2.2	2.5	7	6	4		40
17	1.7	2.0	2.1	6	5	3.1		40
18	1.5	1.8	1.9	5	4.5	2.6		45
19	1.3	1.6	1.6	4	4.0	2.4		45
20	1.2	1.3	1.5	3.5	3.3	2.1		45
21	1.0	1.2	1.4	3.1	3.0	1.8		50
22	.9	1.1	1.2	2.7	2.7	1.7		55
23	.8	1.0	1.1	2.3	2.5	1.6		55
24	.7	.9	1.0	2.0	2.2	1.5		55

NOTE.—Softwoods taken to 4 inches top diameter. Northern hardwoods: Beech, birch, and maple to 4 inches top diameter. Southern hardwoods: Chestnut, oak, hickory, basswood, ash, etc., to 3 inches top diameter.

¹ Bulletin 9, State of New York Conservation Commission (adapted in tie and pole production).

² For every thousand feet of lumber about two-thirds of a cord of wood can also be cut from the tops.

³ For every thousand feet of lumber about three-quarters of a cord of wood can also be cut from the top

⁴ For every 10 ties about 1 cord of wood can also be cut from the tops.

⁵ For every 10 poles about 1 cord of wood may be cut also from the tops.

A HOME-MADE HEIGHT MEASURE.

An instrument for measuring the heights of trees can easily be made at practically no cost. (Fig. 5.)

Take a piece of half-inch board 7 by 9 inches and plane it smooth on all sides. Draw the line AB $\frac{3}{8}$ of an inch from the lower

edge and parallel to it. Two inches from the left end of the board draw CD at right angles to AB . Make a mark at E , $6\frac{1}{4}$ inches from D , and another at F , $3\frac{1}{4}$ inches from D . Now draw a line JK through F parallel to AB . Start at D , lay off inches and quarter inches on AB in both directions, marking D as zero and putting down the number of inches from D to each inch mark. Do the same for the line

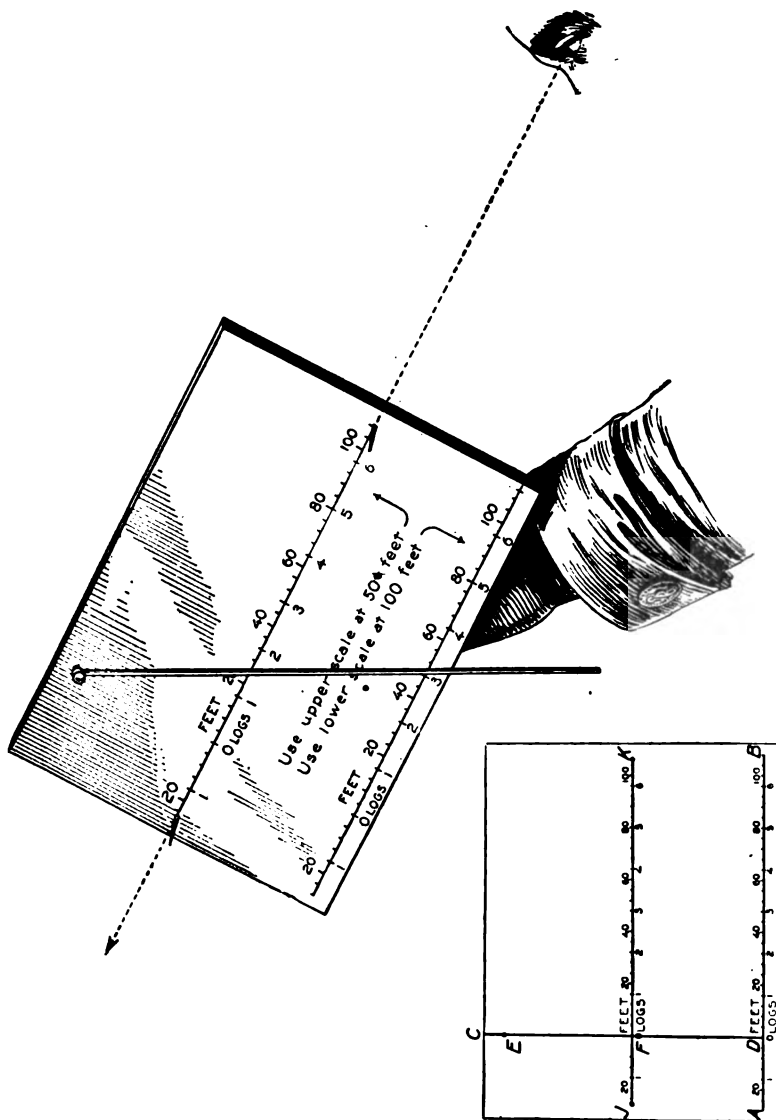


FIG. 5.—A simple home-made instrument for measuring heights of trees.

JK . Take a brad or small nail and drive it in carefully on the line JK about an inch from the edge of the board. Drive it in until the point comes out on the back of the board; then pull it out and drive it in from the back until the point sticks out about one-fourth inch from the face of the board. File off or cut off with pliers any part of the brad that projects from the back of the board. In the

same way insert another brad near the other end of the line *JK*. These brads are the sights, and it is important that they be straight and true.

Now take a piece of straight, heavy wire 10 inches long, and bend one end of it into a loop about an eighth of an inch in diameter. The center of the loop should be in line with the straight part of the wire thus:  not thus . Fasten this piece of wire loosely

to the board at *E* with a half-inch screw, so that it will swing freely when the board is on edge. The loop should be big enough to fit loosely over the shank of the screw, but small enough so that it will not slip off over the head.

Screw a piece of wood about 6 inches long, 1 inch wide, and half an inch thick to the back of the board to serve as a handle, and the height measure is complete.

How to use it.—To measure the total height of a tree, stand at a distance of 100 feet from it and hold the instrument in the right hand in such a way that the pendulum swings freely but very near the board. Sight along the brads at the top of the tree and let the pendulum come to rest. Then with the left hand press the pendulum against the board without giving it a chance to change its position. Now read off the number of feet in height on the lower scale. If the wire crosses the line 5 inches from the point *D*, it indicates that the tree is five 16-foot logs or 80 feet high above the level of the eye. Now sight at the foot of the tree and take another reading. If the pendulum hangs to the left of *D*, that is, between *A* and *D*, add the amount indicated to the first reading, and the result will be the total height of the tree. Thus, if it hangs half an inch to the left of *D*, add half a log or 8 feet to the first reading, making a total of 5½ logs, or 88 feet. But if the eye is below the foot of the tree, the wire will hang to the right of *D* (between *D* and *B*) and then the amount of the second reading should be subtracted from the amount of the first. Thus, if the first reading is 96 feet and the second is 12 feet (to the right of *D*), the total height of the tree will be 96 less 12, or 84 feet. If the tree is less than about 75 feet high, or if it is difficult to see the top at a distance of 100 feet, the observer should stand 50 feet from the tree, but in this case the readings are on the line *JK*.

When the instrument is sighted the pendulum can be kept in position by tilting the hand slightly to the right. This brings the wire against the board and holds it in place so that a reading can be obtained. Care should be taken, however, so that the wire will not slip after the board is tilted.

In the example given, the total height of the tree has been measured. It is often of more practical importance to measure the height to a point on the tree beyond which there is no merchantable saw timber. This measurement is made in the same way as that described above, except that the instrument is pointed at what will be the top of the last log when the tree is cut, and then at the point where the top of the stump will be.

ESTIMATING WITH VOLUME TABLES.

A volume table gives the same information about a whole tree that a log rule gives about a log; that is, the average number of board feet which a tree of any given size is estimated to contain.

Such tables are made by scaling a large number of trees and finding the number of board feet in each, then grouping those of the same size together and averaging them. The table gives the average number of board feet in trees of the sizes measured. Trees differ in shape, and even those of the same height and diameter will vary a good deal in contents, but when many trees are measured the averages are fairly dependable. A volume table which would give an accurate total if applied to all the trees on a tract might show a result containing an error of from 25 to 50 per cent if applied to only one or two trees.

Since different kinds of trees differ from each other in form, the volume table made for one species does not necessarily apply accurately to another. There is not so much difference between the individual hardwoods or individual softwoods as between hardwoods and softwoods. Table 9 is to be used as a general volume table for hardwoods (broadleaf) and Table 10 for softwoods (conifers). Certain factors are given by which correction can be made so as to produce accurate results for different kinds of trees; for example, the hardwoods table applies to red oak without correction, but for white oak 10 per cent must be added when the trees are over 16 inches in diameter.

Estimating the timber on a tract by means of volume tables is not so accurate as estimating each log in each tree separately; but it can be done much more quickly and is accurate enough under ordinary circumstances.

The trees are tallied in a different manner from that indicated where volume tables are not used. If the table is made to show the volumes of trees of various diameters and log lengths, a tally sheet must be prepared so that the trees may be tallied in the same units. A sheet of this kind, which can be ruled on paper, is shown below. The kinds of trees for which different stumpage prices are paid should be kept separate in order that the correct values can be calculated.

Sample tally sheet for tallying trees when volume tables are available.

ACRE No.

Diameter, breast- high.	White oak.			Black oak.			Tulip poplar.			Hickory.			Chestnut.			Etc.					
	1-log.	2-log.	3-log.	1-log.	2-log.	3-log.	1-log.	2-log.	3-log.	1-log.	2-log.	3-log.	1-log.	2-log.	3-log.	1-log.	2-log.	3-log.	1-log.	2-log.	3-log.
<i>Inches.</i>																					
8.....																					
10.....																					
12.....																					
14.....																					
16.....																					
18.....																					
20.....																					
22.....																					

TABLE 9.—*Contents in board feet of hardwood trees of different diameters and merchantable heights.*

[Stump height, 2 feet. Trees over 75 years old. Scribner decimal C rule.]

Diameter, breast-high.	Number of 16-foot logs.									Diameter inside bark of top.	Basis.
	1	1½	2	2½	3	3½	4	4½	5		
	Volume—board feet.										
Inches.										Inches.	Trees.
8.....	20	27	35	43	-----	-----	-----	-----	-----	6	1
9.....	20	32	42	53	-----	-----	-----	-----	-----	6	2
10.....	20	36	52	64	81	-----	-----	-----	-----	6	4
11.....	21	43	62	78	98	120	-----	-----	-----	6	3
12.....	23	50	73	93	120	140	180	-----	-----	7	4
13.....	25	58	86	110	140	170	200	-----	-----	7	9
14.....	27	67	100	130	160	190	230	260	-----	8	15
15.....	30	77	120	150	180	220	260	300	-----	8	19
16.....	34	89	130	170	200	250	290	340	390	9	40
17.....	38	100	150	190	230	280	320	380	440	9	56
18.....	43	120	170	210	260	310	360	420	490	10	65
19.....	48	130	200	240	290	350	400	470	540	10	75
20.....	54	150	220	270	330	390	450	520	590	11	86
21.....	62	170	250	300	370	440	500	580	650	11	90
22.....	69	190	270	340	410	480	550	640	720	12	67
23.....	77	210	300	380	450	530	610	700	790	12	89
24.....	85	230	340	420	500	580	670	770	860	13	56
25.....	93	250	370	460	550	640	740	840	940	13	89
26.....	100	280	410	510	600	700	810	910	1,020	14	68
27.....	110	300	450	560	660	770	880	990	1,110	14	81
28.....	120	330	490	610	720	830	960	1,080	1,200	15	61
29.....	130	360	530	660	780	900	1,030	1,160	1,300	15	47
30.....	140	390	580	720	850	980	1,120	1,250	1,400	16	45
31.....	-----	420	630	770	910	1,050	1,200	1,350	1,510	16	40
32.....	-----	450	690	830	980	1,130	1,290	1,450	1,620	16	40
33.....	-----	480	740	890	1,050	1,211	1,380	1,560	1,730	17	30
34.....	-----	-----	800	950	1,120	1,290	1,480	1,670	1,860	17	30
35.....	-----	-----	860	1,010	1,180	1,360	1,570	1,790	1,990	18	22
36.....	-----	-----	920	1,070	1,250	1,460	1,680	1,910	2,140	18	17
37.....	-----	-----	-----	1,130	1,320	1,550	1,780	2,040	2,290	19	24
38.....	-----	-----	-----	1,190	1,390	1,640	1,880	2,170	2,450	19	11
39.....	-----	-----	-----	1,250	1,460	1,730	2,000	2,300	2,600	20	16
40.....	-----	-----	-----	1,311	1,540	1,820	2,120	2,430	2,760	20	15
41.....	-----	-----	-----	-----	1,610	1,910	2,240	2,570	2,930	21	6
42.....	-----	-----	-----	-----	1,680	2,000	2,360	2,720	3,100	21	3
43.....	-----	-----	-----	-----	1,750	2,090	2,470	2,860	3,270	22	2
44.....	-----	-----	-----	-----	1,830	2,190	2,590	3,010	3,450	22	3

Correction factors for different species.

Chestnut, for diameters from 0 to 40 inches, subtract 10 per cent.

Chestnut oak, for diameters from 32 to 40 inches, add 10 per cent.

White oak, for diameters from 18 to 40 inches, add 10 per cent.

Red oak, for all diameters, use the table without change.

It will be noticed that the volume tables which are based on diameter and number of logs (merchantable lengths) use a 16-foot log as a standard, but that additional columns showing half logs are given. In estimating any individual tree, the number of logs and half logs contained in it is estimated and indicated on the tally sheet.

A 16-inch, 2-log tree would be tallied by putting a dot in the square opposite 16 inches and in the column headed 2. The trees may be tallied by fives; that is, four parallel marks and a fifth one across the first four, thus: ; but unless this method is preferred,

trees should be tallied in tens, because by this method more trees can be shown on the same amount of space. The first four trees are indicated by dots and the next six by connecting lines. Each com-

plete square with its diagonals indicates ten trees. The different stages by which the tally is built up are shown below:

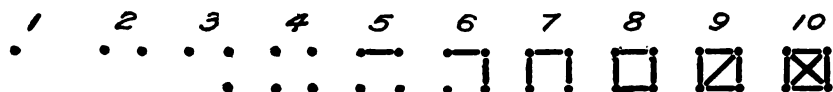


TABLE 10.—*Contents in board feet of coniferous trees of different diameters and merchantable heights.*

[Stump height, 2 feet. Diameter (inside bark) of top, 6 inches. Trees over 75 years old. Scribner decimal C rule.]

Diameter breast-high.	Number of 16-foot logs.							Basis.
	2	2½	3	3½	4	4½	5	
	Volume—board feet.							
<i>Inches.</i>								<i>Trees.</i>
8.....	37	52	66	75	84	-----	-----	12
9.....	41	58	70	82	93	-----	-----	9
10.....	47	66	77	92	100	120	-----	12
11.....	53	74	86	100	120	140	-----	13
12.....	60	83	97	120	140	160	200	8
13.....	68	94	110	130	160	190	220	4
14.....	77	110	120	150	180	210	240	7
15.....	-----	120	140	170	200	240	270	11
16.....	-----	130	160	190	230	270	310	20
17.....	-----	150	180	220	260	300	340	21
18.....	-----	170	210	250	290	330	390	20
19.....	-----	190	230	280	320	370	420	34
20.....	-----	210	260	310	360	410	470	27
21.....	-----	-----	280	350	400	460	520	33
22.....	-----	-----	320	390	440	510	570	40
23.....	-----	-----	360	430	490	560	620	37
24.....	-----	-----	400	470	540	620	680	37
25.....	-----	-----	440	520	600	680	740	47
26.....	-----	-----	480	560	660	740	810	52
27.....	-----	-----	-----	600	720	800	880	43
28.....	-----	-----	-----	650	780	870	950	45
29.....	-----	-----	-----	-----	840	940	1,030	39
30.....	-----	-----	-----	-----	910	1,010	1,100	47
31.....	-----	-----	-----	-----	-----	1,080	1,180	40
32.....	-----	-----	-----	-----	-----	1,150	1,260	44
33.....	-----	-----	-----	-----	-----	1,230	1,340	39
34.....	-----	-----	-----	-----	-----	-----	1,420	36
35.....	-----	-----	-----	-----	-----	-----	1,500	34
36.....	-----	-----	-----	-----	-----	-----	1,580	29
								840

Correction factors for different species.

Hemlock:

- For diameters from 8 to 10 inches, add 10 per cent.
- For diameters from 11 to 20 inches, add 22 per cent.
- For diameters from 21 inches and up, add 20 per cent.

Red spruce:

- For diameters from 8 to 10 inches, add 5 per cent.
- For diameters from 11 inches and up, add 25 per cent.

Shortleaf pine:

- For diameters from 10 inches and under, add 15 per cent.
- For diameters from 11 to 19 inches, add 25 per cent.
- For diameters from 20 to 23 inches, add 35 per cent.
- For diameters from 24 inches and over, add 40 per cent.

White pine: For all diameters, use the table without change.

The volume tables are based on diameter breast high, which is the diameter outside bark 4½ feet from the ground. This diameter can be conveniently measured by means of tree calipers; but calipers are somewhat expensive, and an ordinary carpenter's steel square can be used.

The square is kept horizontal. Both arms are placed in contact with the tree, the shorter one pointing away from the operator; a narrow strip of wood can then be laid against the opposite side of the tree and parallel to the short arm. The diameter of the tree will then be indicated on the long arm.

When the whole area has been estimated, the operator will have a tally of the total number of trees of each size and kind on the tract. Suppose that there are 12 three-log red oaks 18 inches in diameter and that the volume table for hardwoods indicates that trees of this size contain 260 board feet. The 260 is multiplied by 12. The same thing is done for each of the other sizes for which there is a tally. This gives, then, the total number of board feet of red oak. The same thing is done for other kinds of hardwoods, except that after the total volume has been found it may be necessary to increase it or decrease it for the different species by the amounts indicated in the footnote to the table.

PARTIAL ESTIMATES.

In case the woodlot is so large or the time available is so short that it is not practicable to measure each tree, a partial estimate can be made. One-quarter of the area may be gone over and this quarter considered a fair sample of the whole woodlot. The amount on this sample area may then be multiplied by 4 to get an estimate of the total stand on the whole tract.

Different methods of measuring part of the stand are possible. The simplest of these is to lay out squares or rectangles containing a quarter of an acre, or 1 acre, and to measure all the trees on these plots. If the whole woodlot contains 50 acres and if 10 plots containing an acre each are measured, one-fifth of the area would be covered; therefore the amount of timber found on these plots would have to be multiplied by 5 to obtain the total stand.

There is a tendency in locating plots of this kind to pick out areas where the timber is better than the average. This should be avoided because it leads to too high an estimate of the woodlot. A plot 208 feet square contains very nearly 1 acre, and one 104 feet square contains a quarter of an acre.

If the diameter of each tree is to be estimated and not actually measured and the estimator is working without assistance, he may stand at a given point and estimate all of the trees within 59 feet of him. The area of a circle of this size is a quarter of an acre.

A modification of the sample-plot method is the strip method. Instead of measuring out plots here and there the timber on a strip 66 feet wide is measured. An area of this width and 660 feet long measures 1 acre. At the end of each acre (every 660 feet) a new tally sheet is begun. The timber is estimated in a continuous strip across the tract. When the boundary of the woodlot is reached the estimating crew measures off a certain distance (say, 264 feet) at

right angles to the strip, and starting there continues the estimating, this time going back toward the first boundary line, and so on. This results in the gridironing of the tract by these sample areas in such a way that almost invariably all classes of timber are tallied in their proper proportion. (See fig. 6.)

The distance between the center lines of the strips determines what proportion of the tract is covered. If this distance is only 66 feet, all of the tract has been covered; if it is 132 feet, half of the tract; 264 feet, one-quarter of the tract, and so on.

To estimate timber by the strip method it is necessary to have two or more men in the estimating crew. The distance along the strip may be measured with a tape or chain or it may be estimated fairly

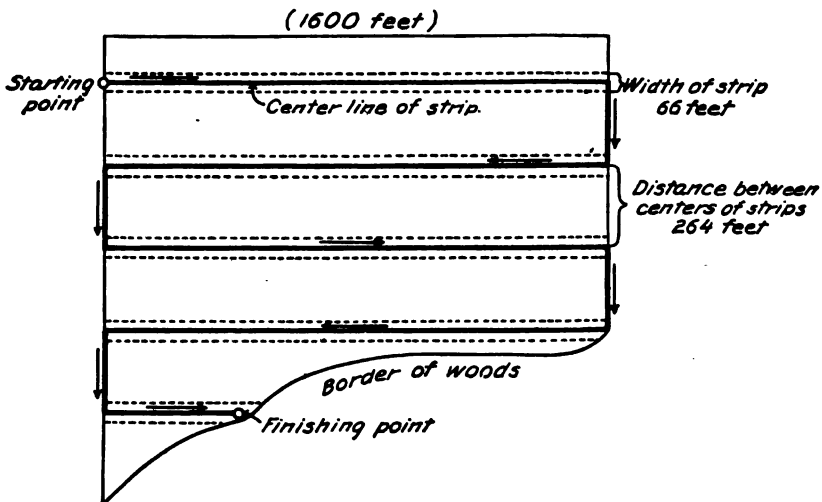


FIG. 6.—Strip method of estimating 25 per cent of a stand of timber.

closely by pacing. The tallyman walks along the center line of the strip and the caliper man or estimator measures or estimates the timber on an area 33 feet wide on each side of the tallyman. If the trees are actually calipered it takes longer, of course, than if the diameters are estimated by the second man. The estimator calls out the species, the diameter, and the height of the tree or number of logs in it; and the tallyman makes the proper entries.

The greater the proportion of the tract which is covered by the strip method the more accurate will be the results; and as a rule at least one-quarter of the area should be included in the strips. This means that the center lines of the strips should be not more than 264 feet apart.

For woodlots of 50 acres or less it is recommended that each merchantable tree be estimated separately. For tracts greater in size either the strip method or the sample-plot method may be used. If only a rough estimate is desired the sample-plot method can be used to advantage in any case, because it is quicker and its accuracy depends on the care with which the plots are located.

ESTIMATING CORDWOOD.

Cordwood can be estimated without volume tables in much the same way as saw timber. The diameter of the stick is measured at the middle outside bark instead of at the small end inside bark. The figures below show the volume in cubic feet of 4-foot sticks of ordinary dimensions.

Diameter of sticks (inches)-----	2	3	4	5	6	7	8	9	10	11	12
Solid contents (cubic feet)-----	0.1	0.2	0.3	0.5	0.8	1.1	1.4	1.8	2.2	2.6	3.1

The branches, or that part of the stem which is suitable for cordwood, may be laid off by eye into 4-foot lengths, then the diameter at the middle of each of these is estimated and tallied on a sheet of paper ruled in squares. The total number of sticks of any size is multiplied by the number of cubic feet corresponding to that size, which is obtained from the table; and this is continued until the total volume of each class of sticks has been obtained. These volumes added together give the total number of cubic feet in the tree or trees under consideration.

Though a cord contains 128 cubic feet the space occupied includes both wood and air. The actual solid contents of a cord is only about 70 per cent of this amount, or 90 cubic feet for wood of average size. To obtain the number of cords it is necessary, then, to divide the total number of cubic feet by 90. For small sticks, where the average diameter is 4 inches or less, a converting factor of 80 cubic feet per cord should be used; in the case of larger sticks 10 inches or over in diameter the converting factor may run as high as 100 cubic feet per cord. For ordinary firewood sizes 90 cubic feet will be satisfactory. Crooked rough sticks can not be piled as closely as straight smooth sticks. Therefore a certain quantity of crooked wood will make a greater number of cords than the same amount of straight wood.

There are usually from 500 to 600 board feet in a cord. Cords may be converted into board feet by multiplying board feet into cords by dividing by this number. Thus 10 cords of medium-sized pulp wood, containing 500 board feet per cord, are equivalent to 5,000 board feet. Large-sized wood, however, might contain 600 board feet to the cord, so that 10 cords would be equivalent to 6,000 board feet.

In some cases it may be desirable to know how much the volume will be reduced by peeling cordwood. The thinnest barked trees usually have at least 6 per cent of the total volume in the form of bark and from this it ranges up to 30 per cent.

FINDING THE SALE VALUE OF STANDING TIMBER.

Woodlot owners often sell their timber without having a sufficient knowledge of its market value to protect their interests, and suffer loss in consequence. Such loss can be avoided only by a careful and thorough study of all available markets.

IMPORTANT STEPS.

The following steps may be of assistance in acquiring a knowledge of the sale value of timber:

(1) Take advantage of the experience of neighbors who have recently sold timber or have otherwise informed themselves in regard to good markets and current prices.

Doubtless the preponderance of poor bargains over good ones has something to do with the proverbial reticence of farmers on the subject of their timber sales. It is not unusual to find cases where adjacent farmers have sold approximately the same grade of material at about the same time for widely different prices. In communities where the cooperative spirit is strong stumpage values usually become pretty well known.

(2) Apply to the State forester, the county agricultural agent, or any other available public official or personal agency for sources of information and advice regarding possible markets and timber prices.

(3) Employ the services of some reliable man who has made a special study of market prices of logs and lumber. The saving gained thereby, unless the owner has had much experience along that line, may amount to from 10 to 40 times the cost of the examination.

The opportunity in this field is particularly promising. In most sections where timber has been sold to any extent in the past, men of the necessary qualifications can be found whom such employment by the day or the job would enable to keep up with market conditions and be of very real assistance to owners of timber.

(4) Get into touch, through correspondence, with outside buyers, and thus awaken competition among as many prospective purchasers as possible. A live effort along this line will often succeed in bringing about an open market for standing timber.

(5) Determine the value of the material by reference to current market prices and the total cost of putting it on the market.

STUMPAGE VALUE.

The sale value of standing timber, known as its stumpage value, is of primary importance to the owner. Most woodlot timber sales are based upon the value of timber in the standing tree, rather than on its later value when cut and placed on the market in the form of cordwood, ties, poles, bolts, logs for further manufacture, or lumber.

With a knowledge of the market price and the cost of getting the material from the stump to the market the owner is in a position to ascertain by a simple calculation the value of his standing timber. This is the difference between the value of the product on the market and the total costs of marketing, including a reasonable profit on the

operation, which may fairly be placed at from 20 to 25 per cent on the combined investment in timber, labor, and lumbering equipment.

For example, if average mill-run red-oak lumber is worth \$24 per thousand feet at a market point and the total cost of logging, sawing, and hauling, including a fair profit on the business, is \$11, the value of the standing timber is \$13 per thousand board feet. In the same manner the stumpage value of poles, ties, and other primary timber products may be obtained. If a 35-foot chestnut pole is worth \$4 delivered at a loading point along the railroad, and the cost of logging and hauling, plus a profit of 20 per cent on the operation, is \$2.10, the stumpage value is \$1.90. Likewise, if the average value of a No. 2 white-oak tie is 56 cents and the cost of cutting, hewing, and hauling, plus a fair profit, is 29 cents, the stumpage value would be 27 cents. Maple and beech cordwood, selling for \$5.60 per cord in a given town and costing \$1 for cutting, \$3.50 for hauling, and 30 cents profit, a total of \$4.80, has a stumpage value of 80 cents per cord.¹

The value of timber in the tree is affected by its location and accessibility, since these determine largely the cost of production and marketing. The distance, character of the road, and daily hauling capacity of a team and wagon are factors to be taken into account. Through improved methods of logging and transportation, timber becomes relatively more accessible, and the cost of production is reduced, its stumpage value being then increased. Efficiency of labor, teams, and machinery employed in logging, economy in utilizing material and conducting the operation, and skill in securing the best market for the product, whether sold in the log or in a manufactured state, all count as factors in raising the value of standing timber.

TABLE 11.—*Equivalent lumber values of four different sizes of ties sold at various prices.*

[Cost of sawing assumed to be \$4 per thousand board feet for 1-inch lumber, and 10 cents per tie. Loss of one-fifth the timber scale by sawing 1-inch lumber as compared to sawing the material into ties.]

Size of tie.	Price received per tie—cents.									
	30	35	40	45	50	55	60	65	70	75
Value per thousand board feet, 1-inch lumber.										
No. 1: Size, 7 by 9 inches by 84 feet (contents, 45 board feet or 22 ties per M board feet).....				\$13.72	\$15.11	\$16.50	\$17.89	\$19.28	\$20.66	\$22.05
No. 1: Size, 7 by 8 inches by 84 feet (contents, 40 board feet or 25 ties per M board feet).....			\$13.38	14.94	16.50	18.06	19.63	21.19	22.75	24.31
No. 2: Size, 6 by 8 inches by 8 feet (contents, 32 board feet or 31 ties per M board feet).....		\$13.61	15.53	17.46	19.38	21.30	23.23	25.15		
No. 3: Size, 6 by 6 inches by 8 feet (contents, 20 board feet each or 50 ties per M board feet).....	\$16.50	19.63	22.75	25.88	29.00					

¹ For a detailed discussion of stumpage value and costs of production of hardwood lumber, ties, poles, and cordwood in southern New England, see Forest Service Bulletin 96, "Second-Growth Hardwoods in Connecticut," by E. H. Frothingham. Approximate values for New York are given in Bulletin 9, "Woodlot Forestry," by R. Rosenbluth. State of New York Conservation Commission. Tables of values for white pine will be found in U. S. Department of Agriculture Bulletin 13, "White Pine Under Forest Management," by E. H. Frothingham, and "Marketing White Pine in New Hampshire," by J. H. Foster, Extension Bulletin No. 3, New Hampshire College and Experiment Station.

In determining stumpage values it is only fair to base the calculation upon the product of highest value for which the tree is suited. For example, if white oak is sawed into wagon stock of specified sizes worth \$40 per thousand board feet, the return in stumpage value is \$28¹ for each thousand feet of lumber sold. It would be only \$14.90² if the same material had been sawed into ties worth 70 cents each. Allowing a sawing cost of 10 cents each for ties and \$4 per 1,000 feet for sawing 1-inch lumber, a given amount of log material will net \$15, whether sawed into ties (7 by 8 inches by 8½ feet) and sold at 70 cents each or into inch lumber at \$22.75 per thousand feet.³ Table 11 gives the equivalent returns per thousand board feet of 1-inch lumber for material worked into ties of different sizes and sold at various prices. For example, if No. 2 ties (6 by



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FIG. 7.—Three-quarters of a cord of chestnut wood for extract, on the way to the railroad yards. (The wood is cut 5 feet long, which is the length specified in this region (East Tennessee) by all the acid plants. From 12 to 14 cords make an ordinary carload.)

8 inches by 8 feet) are selling at 50 cents each, the returns are approximately equal to selling the same material in the form of lumber at \$19.38 per thousand board feet.

If the owner takes part in the lumbering, his profits from his stumpage value are added to by profits from the operation proportional to the extent to which his labor and capital go into the logging, milling, and marketing the product. Under certain conditions he may be able actually to sell the sawed product of his woodlot. Usu-

¹ Allowing a cost of \$12 per thousand for production and marketing of 1,000 feet of lumber.

² Allowing \$7 for making and marketing 31½ ties, the number of 7 by 8 inch by 8½ foot ties derived from the material yielding 1,000 feet of rough lumber, using a saw cutting ¾-inch saw kerf.

³ One-fifth of the timber scale is lost by saw kerf with the ordinary circular saw, and therefore a tie containing 40 board feet by actual scale would yield only 32 board feet of 1-inch lumber.

ally the farmer is not equipped or experienced sufficiently to accomplish this profitably. He is able, however, in many cases to market his timber direct to the consumer in the form of logs, bolts, poles, piling, and cordwood. In general an advance in stumpage values of all woodlot products has been in progress throughout the country. It would be very profitable for the farmer to make a greater effort to acquaint himself fully with general market conditions and stumpage values and to place a corresponding value on his timber resources before making further sales or even local use of his timber.

MARKETING COSTS.

The principal operations necessary to get the product from the stump to the market are:

(1) Cutting, logging, and roughworking the trees in the woods. This includes such operations as cutting logs and bolts, hewing ties, peeling poles, etc., and often ranking and piling them for convenience. In case the material is worked up in a portable mill on the ground or near by, the short haul to the mill should be included here.

(2) Transporting the product of whatever kind to the railroad, wood-using plant, sawmill, town yard, or other market. The assumption here is that the material is sold and shipped considerable distances, so that it is known to have a certain value at some definite point.

(3) Further manufacture to produce certain kinds of products, such as sawed lumber, sawed ties, etc. Bolts, hewed ties, poles, mining timbers, and other products require no further treatment for their marketing.

Usually local cost figures for logging and roughworking are readily obtainable. The most variable cost is that of hauling and transportation, because of the varying distances, means of transportation, and differences in weight of different kinds of timber in a green and seasoned condition. The third item, the expense of sawing lumber, ties, or other materials before they are considered to be on the market, is probably the least variable of the three different items. The density and weight of the wood has a good deal to do with the transportation and milling items in the marketing costs.¹ Pine and cottonwood, for instance, cost less to haul and cut than oak and hickory.

MARKETS AND PRICES.

The farmer's market will be found at a sawmill, lumber yard, wood-manufacturing plant, railroad station or siding, mining company, electric-light company, traction company, or general contrac-

¹ Average marketing costs, itemized separately for lumber, ties, poles, cordwood, and charcoal in New York will be found in Bulletin 9, "Woodlot Forestry," State of New York Conservation Commission, 1913; also, for white-pine lumber in New Hampshire in Extension Bulletin No. 3, "Marketing White Pine in New Hampshire," New Hampshire College and Experiment Station, Durham, N. H.

tor's office. The market may be local or at some distance. In most regions where supplies are limited and prices high the stationary sawmill, obtaining its raw products by rail and long-haul wagon delivery, is superseding the portable mill. This is particularly true in the regions of oak, hickory, and other more valuable hardwoods. Markets for bolts, billets, posts, piling, and logs of various species may very often be found by consulting the wood-manufacturing industry bulletins and woodlot marketing bulletins, published by various States, containing lists of firms making different commodities. In some of these is given the kind of woodlot material purchased as raw product.

It is well to have clearly in mind the different prices for wood products as they advance successively from the tree to manufacture and market. Thus the stumpage price and the market price, or base price, stand at the two extremities. Local and f. o. b. prices are intermediate prices. By "local" price is often meant that which the buyer would pay for wood material delivered at the railroad or other supply point. The "f. o. b." price is the price of material "free on board" cars at some point designated, as f. o. b. mill or f. o. b. railroad. It equals the base price, or price on the general market, minus the cost of freight from the shipping point to the market point.

Market values of timber products may be learned from local mills and lumber yards, markets and jobbers in the cities, and various lumber journals and other publications devoted to the lumber interests. Some companies or bureaus throughout the country make a business of furnishing actual selling prices in the more important lumber-market centers and listing stock for sale.¹ Through large lumber manufacturers and lumber-selling associations in different parts of the country, base prices at stated points, and sometimes reported mill prices, may be obtained. These base prices show the comparative values of different species, although the current selling prices may in many cases vary considerably.² In a number of the northern and central States, woodlot experts are working under the direction of the State forester, to whom applications for information on values and prices in local and distant markets should be directed.

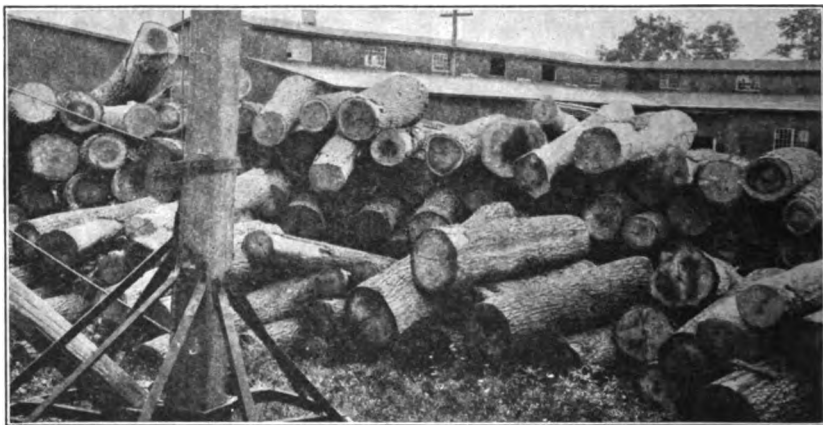
For prices and specifications on crossties, requests should be made to the local railroad agent or direct to the general purchasing agents, whose addresses can be obtained from the passenger-service folders or learned by inquiring at the local stations. Mining companies

¹ The Lumberman's Bureau, Washington, D. C., furnishes such information for the eastern United States. Branch offices are located at St. Louis, Mo.; Memphis, Tenn.; and Hattiesburg, Miss.

² The Forest Service compiles quarterly reports of current sales and furnishes averages on species by regions. These general averages, however, are of relatively little use in local sales of small amounts of timber.

furnish similar information in regard to their needs. Poles are purchased by electric lighting and power companies, electric traction companies, telegraph and telephone companies, and others, to whom requests for information should be sent direct. For prices on piling it would be well to look to the railroad and to dock, wharf, bridge, and bulkhead contractors in the larger towns and cities. Cordwood is purchased by brickmakers, bakeries, lime-kiln operators, packing houses, and fuel dealers.

Owners desiring information regarding prices and the location of manufacturing plants will find it useful to communicate with manufacturers' associations throughout the eastern portion of the United States, where the marketing of farm-grown timber assumes special importance.¹ The associations include in their membership makers of cooperage, veneer and panels, vehicles and implements, paper and pulp, and lumber.



F-52320-A

FIG. 8.—Yellow poplar and white oak logs at a veneer plant. (This class of log is worth from \$30 to \$50 per thousand feet on the yard.)

State foresters are often able to furnish valuable hints and other assistance in locating buyers of rough materials from the farm woodlot, and should be consulted by owners desiring such aid.

SHIPPING BY RAIL.

When a shipment is to be made by rail, obtain from the local railroad agent the freight rate in carload lots for the given commodity between the shipping point and the destination. The rate obtained is then applied to the total weight of the commodity as shown in Tables 1 to 5. This will give the approximate but not exact cost of shipment. Rates for shipments in carload lots are generally quoted

¹ These associations are made up mostly of manufacturers, but include some wholesalers and other dealers. Lists of these associations are made up annually, and, if desired, copies may be obtained upon application to the Forester, Forest Service, Washington, D. C. A large number of dealers' associations exist, but are smaller in membership and more local in character than the manufacturers' associations.

per 100 pounds, with a stated minimum weight for which payment must be made. Shipments in less than carload lots are impracticable because of the very high cost. The following example will illustrate the method. Suppose the freight tariff on "bolts" is 6.3 cents per 100 pounds between two specified railroad points, and a farmer wishes to ship a carload of dry elm bolts to a cooperage plant at the given destination. The material weighs 2,400 pounds per cord¹ and 18 cords are to be loaded on the car. The total weight will be 43,200 pounds and the cost will be \$27.22 for the carload, or an average of \$1.51 per cord. Since 40,000 pounds is the minimum weight for this class of material on this railroad, the least charge for a shipment by carload rates would be \$25.20. Thus if less than 16.7 cords are loaded on a car, the cost per cord will increase in proportion as the total weight of the contents falls below the minimum. The tariff sheet of one railroad lists 58 different commodities under the



F-2 WRM

FIG. 9.—Hickory stock 40 inches long for ax, pick, and sledge handles. All from farm woodlots. (Value at the mill from \$6 to \$9 for an 8-foot rick, or from \$9 to \$11 per cord.)

heading, "Lumber and forest products," with minimum weight varying from 34,000 pounds for sawdust and pulpwood to 40,000 pounds for logs, bolts, and firewood. For the heavy cars over trunk lines, and to certain destinations, minimums up to 60,000 pounds are quoted. Cars may not be loaded in excess of 10 per cent of their marked weight capacity. Usually the rate is about the same for the principal kinds of timber products over the same haul. Tables 12 and 13 show the approximate cost per 1,000 board feet of shipping logs and lumber, both green and air dry, of different species, at rates of from 2 to 10 cents per 100 pounds.

¹ Bolts averaging 12 inches in diameter and 3 feet long, making a short cord 3 feet in width. (See Table 2.)

In selling logs and other products to outside markets it is a good thing to effect the sale at a price for the material delivered at the railroad, either in the yard or aboard the cars. Then, the buyer, rather than the farmer, handles the shipping end of the business. The chances are that by this arrangement the farmer may realize more profit than if he had sold f. o. b. the destination point.

TABLE 12.—*Cost of shipping logs, green and air dry, per 1,000 board feet (Doyle scale), at rates of from 2 to 10 cents per 100 pounds.*

[Costs given are for logs measuring 18 inches in diameter at the small end. For 12-inch logs add 40 per cent and for 24-inch logs subtract 15 per cent of the costs given. Weights used are those shown in Table 1.]

Species.	Rate in cents per hundred pounds.								
	2	3	4	5	6	7	8	9	10
	Cost of shipping 1,000 board feet.								
Ash:									
Green.....	\$1.54	\$2.31	\$3.08	\$3.85	\$4.62	\$5.39	\$6.16	\$6.93	\$7.70
Air dry.....	1.36	2.04	2.72	3.40	4.08	4.76	5.44	6.12	6.80
Basswood:									
Green.....	1.32	1.98	2.64	3.30	3.96	4.62	5.28	5.94	6.60
Air dry.....	.82	1.23	1.64	2.05	2.46	2.87	3.28	3.69	4.10
Beech:									
Green.....	1.78	2.67	3.56	4.45	5.34	6.23	7.12	8.01	8.90
Air dry.....	1.40	2.10	2.80	3.50	4.20	4.90	5.60	6.30	7.00
Birch, yellow:									
Green.....	1.84	2.76	3.68	4.60	5.52	6.44	7.36	8.28	9.20
Air dry.....	1.44	2.16	2.88	3.60	4.32	5.04	5.76	6.48	7.20
Cherry, black: ¹									
Green.....	1.46	2.19	2.92	3.65	4.38	5.11	5.84	6.57	7.30
Air dry.....	1.16	1.74	2.32	2.90	3.48	4.06	4.64	5.22	5.80
Chestnut:									
Green.....	1.76	2.64	3.52	4.40	5.28	6.16	7.04	7.92	8.80
Air dry.....	.98	1.47	1.96	2.45	2.94	3.43	3.92	4.41	4.90
Cottonwood: ²									
Green.....	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75	7.50
Air dry.....	.88	1.32	1.76	2.20	2.64	3.08	3.52	3.96	4.40
Elm:									
Green.....	1.66	2.49	3.32	4.15	4.98	5.81	6.64	7.47	8.30
Air dry.....	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40	6.00
Gum, red:									
Green.....	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75	7.50
Air dry.....	1.10	1.65	2.20	2.75	3.30	3.85	4.40	4.95	5.50
Hickory:									
Green.....	2.08	3.09	4.12	5.15	6.18	7.21	8.24	9.27	10.30
Air dry.....	1.66	2.49	3.32	4.15	4.98	5.81	6.64	7.47	8.30
Maple, sugar:									
Green.....	1.80	2.70	3.60	4.50	5.40	6.30	7.20	8.10	9.00
Air dry.....	1.40	2.10	2.80	3.50	4.20	4.90	5.60	6.30	7.00
Oak, red:									
Green.....	2.08	3.09	4.12	5.15	6.18	7.21	8.24	9.27	10.30
Air dry.....	1.40	2.10	2.80	3.50	4.20	4.90	5.60	6.30	7.00
Oak, white:									
Green.....	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
Air dry.....	1.54	2.31	3.08	3.85	4.62	5.39	6.16	6.93	7.70
Sycamore:									
Green.....	1.68	2.52	3.36	4.20	5.04	5.88	6.72	7.56	8.40
Air dry.....	1.16	1.74	2.32	2.90	3.48	4.06	4.64	5.22	5.80
Yellow poplar:									
Green.....	1.22	1.83	2.44	3.05	3.66	4.27	4.88	5.49	6.10
Air dry.....	.90	1.35	1.80	2.25	2.70	3.15	3.60	4.05	4.50
Tupelo: ³									
Green.....	2.10	3.15	4.20	5.25	6.30	7.35	8.40	9.45	10.50
Air dry.....	1.18	1.77	2.36	2.95	3.54	4.13	4.72	5.31	5.90
Walnut:									
Green.....	1.66	2.49	3.32	4.15	4.98	5.81	6.64	7.47	8.30
Air dry.....	1.14	1.71	2.28	2.85	3.42	3.99	4.56	5.13	5.70

¹ Silver maple is about the same as black cherry, which may be substituted.

² For willow use figures for cottonwood, adding 10 per cent for green and subtracting 8 per cent for dry.

³ For black gum use figures for tupelo.

TABLE 13.—*Cost of shipping 1-inch lumber, green and air dry, per thousand board feet, at rates of from 2 to 10 cents per hundred pounds.*

[Weights used are those given in Table 1.]

Species.	Rate in cents per hundred pounds.								
	2	3	4	5	6	7	8	9	10
	Cost of shipping 1,000 board feet.								
Ash:									
Green.....	\$0.80	\$1.20	\$1.60	\$2.00	2.40	\$2.80	\$3.20	\$3.60	\$4.00
Air dry.....	.70	1.05	1.40	1.75	2.10	2.45	2.80	3.15	3.50
Basswood:									
Green.....	.68	1.02	1.36	1.70	2.04	2.38	2.72	3.06	3.40
Air dry.....	.42	.63	.84	1.05	1.26	1.47	1.68	1.89	2.10
Beech:									
Green.....	.92	1.38	1.84	2.30	2.76	3.22	3.68	4.14	4.60
Air dry.....	.72	1.08	1.44	1.80	2.16	2.52	2.88	3.24	3.60
Birch, yellow:									
Green.....	.96	1.44	1.92	2.40	2.88	3.36	3.84	4.32	4.80
Air dry.....	.74	1.11	1.48	1.85	2.22	2.59	2.96	3.33	3.70
Cherry, black: ¹									
Green.....	.76	1.14	1.52	1.90	2.28	2.66	3.04	3.42	3.80
Air dry.....	.60	.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
Chestnut:									
Green.....	.92	1.38	1.84	2.30	2.76	3.22	3.68	4.14	4.60
Air dry.....	.60	.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
Cottonwood: ²									
Green.....	.72	1.08	1.44	1.80	2.16	2.52	2.88	3.24	3.60
Air dry.....	.44	.66	.88	1.10	1.32	1.54	1.76	1.98	2.20
Elm:									
Green.....	.86	1.29	1.72	2.15	2.58	3.01	3.44	3.87	4.30
Air dry.....	.62	.93	1.24	1.55	1.86	2.17	2.48	2.79	3.10
Gum, red:									
Green.....	.78	1.17	1.56	1.95	2.34	2.73	3.12	3.51	3.90
Air dry.....	.56	.84	1.12	1.40	1.68	1.96	2.24	2.52	2.80
Hickory:									
Green.....	1.04	1.56	2.08	2.60	3.12	3.64	4.16	4.68	5.20
Air dry.....	.86	1.29	1.72	2.15	2.58	3.01	3.44	3.87	4.30
Maple, sugar:									
Green.....	.94	1.41	1.88	2.35	2.82	3.29	3.76	4.23	4.70
Air dry.....	.72	1.08	1.44	1.80	2.16	2.52	2.88	3.24	3.60
Oak, red:									
Green.....	1.08	1.62	2.16	2.70	3.24	3.78	4.32	4.86	5.40
Air dry.....	.72	1.08	1.44	1.80	2.16	2.52	2.88	3.24	3.60
Oak, white:									
Green.....	1.04	1.56	2.08	2.60	3.12	3.64	4.16	4.68	5.20
Air dry.....	.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00
Sycamore:									
Green.....	.86	1.29	1.72	2.15	2.58	3.01	3.44	3.87	4.30
Air dry.....	.60	.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
Yellow poplar:									
Green.....	.64	.96	1.28	1.60	1.92	2.24	2.56	2.88	3.20
Air dry.....	.48	.72	.96	1.20	1.44	1.68	1.92	2.16	2.40
Tupelo: ³									
Green.....	1.10	1.65	2.20	2.75	3.30	3.85	4.40	4.95	5.50
Air dry.....	.60	.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
Walnut:									
Green.....	.86	1.29	1.72	2.15	2.58	3.01	3.44	3.87	4.30
Air dry.....	.60	.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00

¹ For silver maple use figures for black cherry, since the weights are about the same.² For willow use figures for cottonwood, adding about 20 per cent for green lumber.³ For black gum use figures for tupelo, since the weights are about the same.

The amount of forest products of any kind that can be shipped in or on a car varies with both the cubical and weight capacity of the car. The following table shows roughly the amount of different kinds of forest products that can be shipped in the average 60,000-pound-capacity car.

Lumber:

Rough ----- board feet-- 15,000 to 18,000

Finished -----do----- 17,000 to 20,000

Logs:

Large, 24 inches-----do----- 5,000 to 7,000

Small, 12 inches-----do----- 4,000 to 5,000

Bolts or butts-----cords-- 12 to 18

Cordwood, 4 feet-----do----- 15 to 18

Stovewood, 16 inches-----ranks-- 30 to 40

Mine timber (see Posts, Poles, Logs).

Poles or piling-----pieces-- 25 to 40

Ties:

7'' by 9'' by 8½'-----do----- 300

6'' by 8'' by 8'-----do----- 350

5'' by 6'' by 5½' (mine tie)-----do----- 1,100

Posts:

4'' top, 7 feet----- 800

6'' top, 8 feet----- 500

Tanbark -----cords-- 16 to 18

Sawdust-----tons-- 12 to 18

WHEN TO SELL.

Woodlot owners do not always know when to sell standing timber and when to use it for local needs. In some localities it unquestionably pays the farmer better at all times to sell it, particularly the more valuable kinds. For example, in the central hardwood region farmers profitably sell their select yellow-poplar trees and with the money purchase and haul back to the farm for distances of from 4 to 8 miles southern-pine siding for their houses and barns. On the other hand, there are too often instances where one finds choice white oak of the best quality for veneer or furniture stock sawed up into posts for the farm.

The woodlot owner should keep in touch with market conditions in order that he may market his product to the best advantage. With rarely an exception the timber is not dying, decaying, or "going back" by fungous or insect attack at the rapid rate alleged by buyers, who, obviously, desire to buy as cheaply as possible; and, unless it is overmature, it is increasing yearly in volume and value. Cutting during the early period often represents a real sacrifice in financial returns. The approximate age at which trees should be cut in order to secure the highest net money returns per year is very different for different species. Thus cottonwood, ash, and yellow poplar become commercially valuable at much earlier ages than white oak and black walnut.

When other farm work is least pressing the farmer should give attention to estimating, measuring, cutting, marketing, and selling his timber. Spare help and time to supervise the work make the winter a favorable season. It is easier to haul logs on the snow than

over ordinary roads, and the logs are less liable than at any other time of the year to deteriorate quickly through attacks of insects or fungi.

HOW TO SELL.

The choice of methods of selling will depend largely upon the kind of timber and the owner's knowledge of its value, his past experience, and the condition of the market. Woodlot products are sold either in the standing tree or in a more or less roughly manufactured condition. Except when sold by the lot or lump, sales are based upon a measure by log scale or lumber tally or upon individual count of units of designated size or character.

SELLING BY LOT OR LUMP.

Timber sold by the lot, boundary, or tract is either "lumped off" to include a designated tract or sold on an acreage basis.

This method has prevailed over all others, particularly in the rougher and less settled districts. As a rule it is strongly favored by the purchaser because in such a transaction his better knowledge of both timber yields and values gives him an advantage over the average woodlot owner. Many examples of the sacrifice by the owner of a large share of the value of the timber can be found in nearly any woodlot region. On account of greater competition among purchasers and an increase in timber values, sales of standing timber by the lot or lump are now being made with better profit than formerly.

In using this method it is very important in advance of the sale (1) to secure a good estimate of the amount, quality, and unit value of each kind of product in the stand; (2) to get bids from as many buyers as possible; and (3) to have an agreement clearly specifying the restrictions in regard to the manner and amount of cutting, so as not to impair the producing power of the forest. The sale may include only trees above a specified minimum diameter limit, or only such trees as have been previously marked by the owner for cutting. Suggestions of conditions which may or may not be included in the timber sale, according to the local conditions and the wishes of the owner, will be found on pages 43 and 44. When safeguarded in the manner suggested above, this method becomes one of the safest and most satisfactory of all methods of selling and should receive full consideration when sales are contemplated.

Selling by lump eliminates the anxiety and misunderstandings attending sales by log-scale measurement. If competition is keen, it is likely that nearly or quite the full value of the timber will be reached in the bids. By this method the owner foregoes the opportunity of profitable employment for himself and his teams which he would have if he logged the material and sold it after hauling it to the mill or shipping point.

Unless restricted by the terms of the agreement, the buyer usually cuts very closely. Selling by the lot is therefore a good method to use where the owner intends to clear the land for other uses. For the same reason, if the land is to be kept in timber, the owner should make provision in the contract of sale to retain sufficient control over the logging operations to protect the young growth and provide for a future crop. The importance of care in cutting, on account of its effect upon the succeeding growth and production of the stand, can hardly be overstated.

SELLING BY LOG SCALE.

Timber is sold at a certain price per thousand board feet, measured in the log.¹ It is sold either "in the tree," in which case the value of the standing timber is all that is considered, or in the log, cut and



FIG. 10.—A black walnut log, 35 inches in top diameter by 12 feet in length, which brought \$135 per thousand feet, or \$05.85 for the log, at the railroad. (The original owner, a farmer, sold the whole tree, standing, for \$50; the buyer felled it, at a cost of \$15, and sold it there for \$138.26; it was resold without being moved for \$164.84, and later sold to a large sewing-machine factory.)

delivered at some designated point, in which case the price is based on the stumpage value plus the labor of cutting and transportation.

The chief concern of the owner in selling his standing timber by this method is to determine in advance the true value and price to be charged per unit of measure. This may be secured as (1) an average or "woods run" for the entire lot, or (2) separated by species and, if desired, by grades under each. The latter is the more accurate and satisfactory method. How to ascertain stumpage values is discussed on page 27. The owner has the choice of selling only selected and marked trees, or all trees above a certain diameter limit and none

¹ In regions where sales are small and values high, it is frequently customary to buy and sell timber by the hundred rather than thousand board feet.

others, or, if he chooses, all merchantable trees. Selling only marked trees gives very good results indeed when the selection is properly done; selling to a diameter limit follows in preference; selling all merchantable trees should not be used in connection with this method, but restricted to sales by the lump or lot, in order to secure full utilization of the lower grades.

Selling standing timber, to be paid for on the basis of the amount determined by scaling up the logs when cut, is one of the most common of methods. A good many sales are made where the owner cuts and delivers the logs to the mill or shipping point. Because the average farmer is not usually equipped to do an extensive business of this character, the method is mostly confined to relatively small sales and often to the higher-priced woods, such as white oak, yellow poplar, white ash, or black walnut. In selling by the log, the owner who measures and grades his timber,¹ even though he does it roughly, has an advantage over one who is obliged to accept without a check the scale and inspection of the purchaser. In case he has not sufficient experience himself, it will usually pay the owner to hire, if necessary, a competent person to give him instruction in the work.

The contents of trees are more valuable when cut into logs and delivered at the mill or on board cars; and by doing this work himself the owner may share the legitimate profit derived from the enhanced value of the commodity. This additional profit can usually be figured as from 20 to 30 per cent of the cost of logging and hauling.

SELLING BY COUNT.

Poles, piling, crossties, small mining timbers, cordwood, etc., are sold by individual count of units of specified sizes.² The smaller sizes of bolts, for example, are sold the same as fuel wood by the cord. Because of its simplicity and ease of application, the method has much to recommend it for use wherever it can be applied in woodlot sales.

SELLING BY LUMBER TALLY.

There are two ways of selling timber to be paid for according to the amount of lumber sawed from it in the mill. In the one case, the woodlot owner takes no part in the logging and sawing, but disposes of his standing timber at a stumpage price per thousand feet of lumber actually produced at the mill. This method of sale is desirable where conditions are such that the material can more easily or more reliably be measured and checked after leaving the saw than while in the log. It is more applicable also to stands of timber consisting of only a few species than to a mixture of many different kinds. Since mill scales as a rule show from 15 to 30 per cent overrun in excess of log scales in common use, the owner secures returns on the full amount of the product sold. In the other case the owner personally takes charge of the logging and milling and markets the

¹ See p. 14 for scaling and p. 2 for grading.

² See pp. 7 to 12 for specifications.

manufactured product. If successful in marketing, he secures the full value of his stumpage and, in addition, a share in the profits derived from the operations of logging and manufacturing. Time, knowledge, and experience necessary to supervise the actual operations or contract for parts of it, and capital to finance and carry on the work are requisites.

In this connection it should be clearly recognized that primarily the farmer is a producer and not a manufacturer. His concern, therefore, is in producing and disposing of the raw product, or the timber as it stands in the tree, rather than in logging and milling. However, with teams, wagons, and spare labor available, particularly during the winter months, he can often find profitable employment in logging, or at least in hauling the logs to the mill or shipping point. The sawing must usually be contracted for, because the investment in sawmill and power outfit would entail too great an expense. In milling and selling, the farmer usually works at a great disadvantage, because he must compete with men whose entire time is devoted to the business. Unless the owner has a definite contract before beginning sawing, he is very likely to find himself later on with lumber on his hands for which there is little demand.

EXAMPLES OF MARKETING.

The advantage to be gained through a knowledge of marketing timber is best shown by a few actual examples:

(a) A woodlot owner in Maryland received an offer of \$1,500 for a tract of timber, which he was inclined to accept as a fair price. Before the sale was made, however, he requested the advice of the State forester as to the amount and value of the timber. As a result the State forester made an examination of the tract, estimated the market value of the timber, and furnished the owner a list of timber operators who might be prospective buyers. The timber was then publicly advertised, with the result that the man who had previously made the \$1,500 offer raised his bid to \$4,500, and the sale was finally made to another person for about \$5,500. Only three months elapsed between the date of the first offer and the final sale. Not only was the original offer increased by nearly 270 per cent, but the woodlot was also left in excellent condition. This was accomplished by having the trees to be cut selected and marked by the State forester with a view to leaving the young growing timber on the ground, together with sufficient seed trees to restock the open places. The contract further called for close utilization by cutting the stumps low and using to small diameters in the tops, the lopping of tops for cordwood, and the scattering of the remaining brush.

(b) An 80-acre farm in south central Michigan had on it a 10-acre woodlot, containing about 48,000 board feet of basswood and about 12,000 each of hard maple, soft maple, red oak, soft elm, ash, and beech. The trees were overmature, many of them hollow; and

the owner knew he ought to "sell them to save them." Timber on an adjacent 10 acres had previously been sold for less than \$100 per acre, or a total of about \$1,000. Even this value compares well with incomes commonly obtained from woodlots in southern Michigan. Instead of selling on the first bid made, however, the owner, acting on the advice of an expert attached to a near-by forestry school, wrote to a number of wood-using firms in different cities, from some of whom, after examination of his timber, he secured bids on the different species in his woodlot. As a result of his bargaining, he received for his stumpage sums amounting, in the aggregate, to nearly \$2,000. For his red oak, bought for quarter-sawing by a firm outside the State, he received \$21 per 1,000 board feet. His other trees were purchased by veneer companies, the basswood re-



F-4 WRM

FIG. 11.—A mill sawing posts and boards from red cedar gleaned from farm woodlots and pastures.

turning \$19 per 1,000 board feet, ash \$16, elm and hard maple \$14, soft maple and beech \$12.

(c) An owner in northwestern Ohio received bids of \$550 and \$600 lump sum for his timber. Following the advice of a relative who had previously run a sawmill, he engaged a portable mill, sawed out, and sold the following at the prices named:

(1) White oak butts, rough lumber for wagon stock, hickory butts for bands, and elm butts for hoops, sold for.....	\$1,350
(2) Barn frame, cut and used on the farm, value.....	600
(3) 500 railroad ties, sold for.....	250
(4) Balance, consisting of cheaper poles, "sap timber, cull, and refuse" sold to the buyer who had offered \$600 for the standing timber for.....	350
Gross receipts from timber.....	2,550
Total cost of operation.....	1,150
Net for stumpage value and profit.....	1,400

It will be noted that \$600 was the highest bid received for the standing timber, whereas he cleared \$1,400.

(d) In western Ohio, a woodlot owner who had carefully protected his best timber for many years accepted in 1914 a local buyer's lump sum offer of \$260 for the timber on 6.5 acres. The trees were tall, clean, good-sized white and bur oak of high grade. By a careful measurement of the stumps and tops, made just after logging, the writer found that the tract had yielded not less than 14,500 board feet per acre, or a total of something over 84,500 board feet.¹ A fair price for this quality of timber would be \$17 per 1,000 feet on the stump. At this rate the timber included in this sale was worth not less than \$1,436, or \$1,176 more than the farmer received for it. Though this may seem to be an extreme case, mistakes only slightly less striking are common.

TIMBER-SALE CONTRACTS.

The woodlot owner should draw up a written contract covering every sale of woodlot products. Even in small sales much trouble and financial loss have resulted from failure to put the terms of the sale in writing.

The primary aim of the seller should be to make absolutely clear the conditions under which he desires to dispose of his product. The essential conditions to be inserted in the complete form of timber-sale contract refer to (1) description and location of the timber; (2) price and manner of payment; (3) conditions of cutting and removal; and (4) title and means of settling disputes. Under the third heading are put down the provisions regarding the duration of the contract, the marking of the timber, the diameter limits, the method of scaling, merchantability, the degree of utilization, and protection against injury.

As an aid to those unfamiliar with such agreements, a sample contract is given, showing the more important provisions that should be included in a contract for the sale of marked trees to be scaled in the log. Substitute clauses are given for use in other kinds of sales. No single form of contract will suit all classes of sales, but owners of woodlot timber should have no difficulty in adapting this contract to their use.

SAMPLE TIMBER SALE CONTRACT.

TIMBER CONTRACT.

AGREEMENT entered into this 16th day of November, 1915, between James Boyd, of Centerdale, Ohio, hereinafter called the seller, and Thomas B. McCord, of New Albany, Ohio, hereinafter called the purchaser.

WITNESSETH:

ARTICLE I. The seller agrees to sell to the purchaser, upon the terms and conditions hereinafter stated, all the living timber marked or designated by the

¹Allowing 10 per cent deduction for possible further defect than was noted.

seller and all merchantable dead timber, standing or down, estimated to be 84,000 board feet, more or less, on a certain tract of land situated in the township of Centerdale, county of Tompkins, State of Ohio, and located on the farm belonging to the seller, and about one-half mile west of his farmhouse.

ARTICLE II. The purchaser agrees to pay the seller the sum of seven hundred dollars (\$700), more or less, as may be determined by the actual scale, at the rate of fourteen dollars (\$14.00) per thousand board feet for white oak and white ash, twelve and 50/100 dollars (\$12.50) for red oak and hickory, eight dollars (\$8.00) for sugar maple and beech, and six dollars (\$6.00) for black gum, blue beech, and ironwood, payable prior to the date of removal of material, in installments of two hundred dollars (\$200) each.

ARTICLE III. The purchaser further agrees to cut and remove said timber in strict accordance with the following conditions:

1. Unless extension of time is granted, all timber shall be cut, paid for, and removed on or before March 30, 1916.

2. Saw timber shall be scaled by the Doyle log rule, and measured at the small end along the average diameter inside the bark.

3. The maximum scaling length of logs shall be 16 feet; greater lengths shall be scaled as two or more logs. Upon all logs an additional length of 4 inches shall be allowed for trimming. Logs overrunning this allowance shall be scaled not to exceed the next foot in length.

4. No unmarked timber of any kind shall be cut, except black gum, blue beech, and ironwood.

5. Stumps shall be cut so as to cause the least possible waste; stumps of trees up to 16 inches in diameter not higher than 12 inches above the ground, and those of trees above this size at a distance above the ground not greater than three-fourths of their diameter.

6. All trees shall be utilized in their tops to the lowest possible diameter for commercially salable material.

7. Young trees shall be protected against unnecessary injury; only dead trees and the less valuable kinds may be used for construction purposes in connection with lumbering operations.

8. Care shall be exercised at all times by the purchaser and his employees against the spread of fire.

ARTICLE IV. It is mutually understood and agreed by and between the parties hereto as follows:

1. All timber included in this agreement shall remain the property of the seller until paid for in full.

2. In case of dispute over the terms of this contract, final decision shall rest with a reputable person to be mutually agreed upon by the parties to this contract; and in case of further disagreement, with an arbitration board of three persons, one to be selected by each party to this contract and a third to be the State forester or his chosen representative.

IN WITNESS WHEREOF the parties hereto have hereunto set their hands and seals this day of 19 .

Witnesses:

The following are specimens of clauses that should be substituted in the contract when other methods of sale are used.

In lump-sum sales substitute in Article I a descriptive clause modeled on this one:

All merchantable living trees, except yellow poplar, white ash, and basswood which measure 13 inches and below in diameter at a height of 1 foot above the ground.

This provision will reserve the basis for a second crop consisting of the more valuable and rapid-growing kinds of trees, and remove all of the inferior and slower-growing trees.

In a sale to a diameter limit the clause should read somewhat as follows:

All merchantable living trees, 14 inches and over, measured at the height of 1 foot above the ground.

The payment clause in lump-sum sales should be varied to read something like this:

* * * the sum of ——— dollars (\$——) for said timber, payable prior to the cutting of the material, in installments of ——— dollars (\$——) each, payable on or before ———, respectively.

Other clauses which might be included are those requiring that the timber shall be scaled in the presence of the seller or his authorized agent; that the log lengths shall be varied so as best to utilize the timber; that unmarked trees, if cut, shall be paid for at double the regular price; that tops left in logging shall remain on the tract for the use of the seller (or, if desired, shall be utilized by the purchaser).

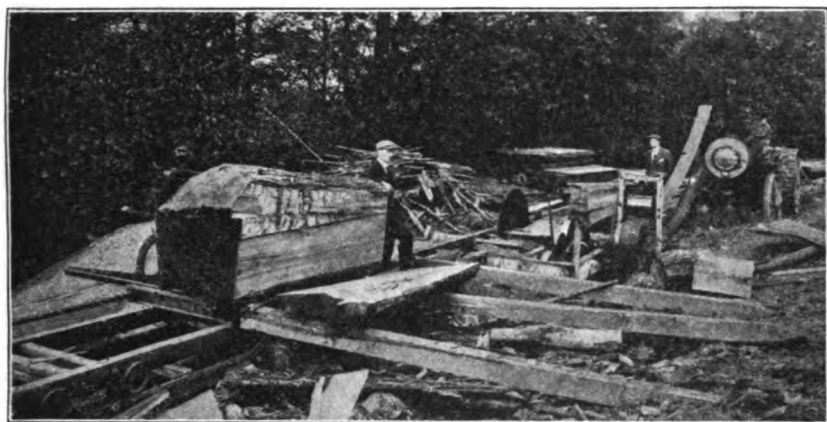
In selling by lump the other essential change is to omit the provisions, or parts of them, referring to scaling, measuring, and unit prices. The total amount to be paid is very important, while the total estimated quantity of timber is optional.

THE SMALL SAWMILL.

Practically all that has been said in regard to the marketing of lumber by the farmer applies equally to the owner of a small portable sawmill. The small millman's interest is closely related to that of the woodlot owner, since the prosperity, success, and profit of both are dependent upon the millman's ability to manufacture carefully and market to good advantage. If the millman shows good management in handling his business, the farmer who sells him his raw materials is certain in the end to obtain larger prices for his stumpage. In fact, practical assistance in marketing given to the small millmen will undoubtedly prove effective in assisting the small owner to secure the full value of his timber.

It is to the advantage of both the woodlot owner who manufactures his product and the millman who buys and saws the farmer's standing timber to work up the logs into the most salable form. In ad-

vance of sawing it is well to secure a definite contract, or at least follow a lumber bill which conforms to standard market requirements of special industries. Advance orders call for stated quantities of material of specified kind, sizes, and grades. The operator of a small portable sawmill is likely to lose money if he saws without due regard for the market requirements in material, sizes, and grades. Investigate the market first, then proceed to cut up the timber. This applies equally to cutting up logs in the woods and running the logs through the sawmill. Great waste, with consequent reduction in profit, results from failure to locate the market before beginning to harvest the crop. Undoubtedly, the present custom had its origin in the customary method of harvesting field crops. The timber crop is, however, essentially different from the field crop



F-59020

FIG. 12.—Portable steam sawmill cutting a log of maximum size for the saw.

in one respect, namely, that there is seldom any necessity for quick harvesting.

COOPERATION IN MARKETING.

There is unquestionably a clear and definite need for cooperation among owners in the selling of woodlot products. The average farmer by himself acts at a great disadvantage, because the whole field of caring for growing timber, selecting trees for cutting, and finding the best market is unfamiliar ground.

Because he has not a carload lot of a particular kind of material and shipment by local freight is absolutely prohibitive, the woodlot owner is obliged in many instances to cut up choice kinds of material into very inferior products; for example, he may find it necessary to turn clear white oak or black cherry into railroad ties and sell his material at a great sacrifice to a local buyer—a middleman. Several farmers acting cooperatively could market their black-wal-

nut logs, basswood, hickory or oak bolts, piling, or other products direct to the wholesaler, manufacturing plant, or user at greatly increased profits over those received from their individual sales.

The services of a reliable and experienced timberman as adviser would be extremely helpful to the majority of farmers. The services of such a man, who is known to be working in the interests of the farmer, are needed:

(1) To estimate the contents and market value of woodlots. The owner will then be in a better position to decide how to sell most profitably.



F-21161

FIG. 13.—A northern woodlot yielding a by-product of much value. (The maple-syrup industry brings good wages to the farmer and his teams during a dull season on the farm.)

(2) To supervise the marketing of timber in carload lots. Because of his superior knowledge such an adviser will be much better fitted to secure current market prices than the average farmer.

In regions where timberwork has been going on for many years men of the necessary qualifications will be quite readily found. They should be selected under the approval of the State forester in States where such an officer is employed. The farmers' timber adviser should be clearly identified with such organizations as the county improvement associations or with the State Extension Service. The farmer might pay a fair price for each piece of estimating and selling, or each county might employ a man whose duty it would be to advise the farmers. Several farmers acting cooperatively could secure the services of the timber agent at relatively small cost to each.

No attempt is made here to work out and recommend a plan of cooperation. This could undoubtedly be effected through the aid of the State and Federal Governments in conjunction with the present farm demonstration and management movement for better buying and selling on the part of farmers. Groups desiring to effect permanent organization can secure assistance and information as to methods and procedure from the marketing and rural organization specialists of the United States Department of Agriculture.

HOW TO PREVENT THE DETERIORATION OF CUT WOODLOT PRODUCTS.

A good rule to follow is to allow as little delay as possible between the felling of the tree and its manufacture into rough products. This means that sales should be arranged for prior to beginning cutting. It is often necessary or desirable, however, to put off the delivery of logs, bolts, poles, etc., until some months after cutting, either in order to allow them to season or because a good sale can not be arranged at once. A great deal of the weight of freshly cut products is due to the water they contain, and a few months' seasoning will often reduce this to a marked degree, the amount of reduction depending, of course, on the climate, the weather, and the exposure to sun and air. At the same time, unless preventive measures are taken, the products are sure to deteriorate through decay, insect attack, checking, or some other agency. A certain amount of deterioration is apt to take place in any case if the delivery is put off for some time; but the amount can be greatly reduced by proper preventive measures.

Logs and other round timber should never be allowed to remain long in the woods after cutting. As soon as possible they should be taken to a dry, well-aired, and unshaded area and placed on skids well off the ground; otherwise the opposite extreme should, if possible, be adopted, namely, of keeping the timber in water. Within a few days after the trees are felled the bark should be removed from poles, posts, and other material which will not be injured by checking or season cracks. The ends of logs should be coated with paint, creosote, or tar. This will not only assist in preventing decay, but will also retard seasoning to some extent and thus keep the logs from checking badly.

Poles should be peeled, and hauled or dragged to a place free from debris or rank vegetation and freely exposed to sun and wind. There they should be rolled upon skidways not less than 18 inches high, so that no part of them will rest on the ground. There should be only one layer of poles on each skidway. When ties are cut, it is usually cheapest and most desirable to haul them, unseasoned, directly to the railroad and there pile them according to the specifications furnished by the tie buyer.

Cordwood should be stacked in loose piles in a sunny, well-aired, and well-drained place free from rank vegetation. Two sticks on the ground running the length of the pile will keep it from contact with the soil and thus prevent decay in the lower layers.

PRACTICAL HELPS IN MARKETING.

The following suggestions may be helpful to the farmer in selling his woodlot products:

(1) Find out from as many sawmills and wood-using industries as possible what prices they offer for various wood products, in order that advantage may be taken of the best market. This applies to sales requiring shipment as well as to local sales.

(2) Before selling, inquire from neighbors who have recently disposed of their timber and use their experience as a guide. Failure to do this has resulted in many instances in not getting the full value of the product.

(3) Thoroughly investigate all local timber requirements and prices, since in many cases local markets pay better prices than outside markets because of the saving of transportation charges.

(4) Advertise in the papers and otherwise secure competition among outside purchasers. The expense will be small and outside buyers will thus learn of chances to bid on timber in competition with local buyers.

(5) Secure bids whenever practicable both by the lump and by log-scale measure. A choice is thus offered and the more profitable form of bid can be accepted.

(6) Consider the responsibility of the prospective purchaser before making the sale, in order to avoid slow payment, costly collections, and losses.

(7) Prior to making sales, secure at least a fairly good estimate of the amount and value of the material for sale. Persons acquainted with the business of measuring or estimating timber can usually be found in every region where timber has been handled in the past.

(8) Market the higher grades of timber instead of using them on the farm for purposes for which cheaper material will prove as serviceable. This should be done in many cases even if it makes necessary the purchasing and hauling of lower priced lumber to the farm. Markets which pay good prices usually buy on grade and inspect closely.

(9) Remember that standing timber does not deteriorate rapidly nor do the uses of wood change greatly within a few years. The owner, therefore, is not forced to place his product on the market regardless of market conditions.

(10) Use a written timber-sale agreement in selling woodlot timber, particularly where the cutting is done by the purchaser.

UNITED STATES DEPARTMENT OF AGRICULTURE



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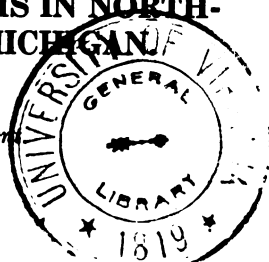
OFFICE OF THE SECRETARY.

Contribution from the Office of Farm Management, W. J. Spillman, Chief.

MANAGEMENT OF SANDY-LAND FARMS IN NORTHERN INDIANA AND SOUTHERN MICHIGAN

By J. A. DRAKE,

Agriculturist, Office of Farm Management



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INTRODUCTION.

This bulletin deals with the problems involved in the improvement and management of farms on the yellow to whitish sandy-land areas¹ which occur in different parts of northern Indiana, southern Michigan, and in a part of northwestern Ohio. It outlines a plan whereby a man with limited means, by beginning with suitable cash crops, may build up one of these farms and at the same time derive some revenue from it, finally developing a well-balanced farm system.

¹ Very light gray to whitish-gray soils with a varying yellowish tinge. These soils would generally be classed as sandy loams, but on the whole are quite sandy, grading in some instances to almost pure sand.

NOTE.—This bulletin, while applying particularly to areas where sandy lands occur in southern Michigan, northern Indiana, and a part of northwestern Ohio, should prove of interest to farmers occupying sandy lands in other portions of the country not too far north to permit of maturing the crops recommended.

The conclusions, drawn from investigational work in the region,¹ are as follows:

The growing of soy beans and cowpeas for seed offers a definite approach to the entire problem of farm improvement in these sandy-land areas of the section.

Soy beans and cowpeas are profitable cash crops on the poorest of these sandy lands, the yields ranging from 5 to 20 bushels per acre, and the present range of price \$1.50 to \$2 per bushel, with a possible minimum of about \$1 per bushel when the seed-growing industry becomes well developed in these sections. Aside from being a source of immediate income under these conditions, these crops furnish the most practical foundation for building up the soil, in addition affording considerable feed for live stock.

Most farms on these sandy lands conform best to a cash-crop rather than a live-stock basis at first. As the soil is built up, as feed can be produced and fences built, it is wise to add gradually such live stock as prove profitable.

It is possible to grow alfalfa successfully on nearly all of these sandy-land farms, but not without following certain definite lines of procedure. In addition to making heavy applications of manure it is necessary to incur considerable expense in the purchase of lime and fertilizers. These sandy lands are not naturally adapted to alfalfa, but with careful and persistent effort this crop will become a valuable addition to those already grown on the average farm.

Vetch has not attained the favor on the sandy lands of this section which it has on similar lands farther north in Michigan. This crop requires greater care and attention than soy beans and cowpeas. Inoculation and manure are generally necessary for satisfactory results. When grown successfully it gives good returns as a seed crop. It is also valuable as a crop to plow under in preparation for corn, soy beans, or cowpeas.

In arranging cropping systems there should be two main objects—improving the land and securing a profit. The chapter in this bulletin on “Rotations and Cropping Systems” outlines a number of systems which meet these demands effectively, and likewise apply to the different stages of development on the average sandy farm of the section.

In general the soil of the sandy-land farms of this region is somewhat reduced in fertility, and partial crop failure is not uncommon. To guard against the effects of this in so far as possible, ample provision should be made for growing an abundant amount of home

¹ The writer desires to acknowledge valuable assistance rendered by Col. C. A. Carlisle, John Bordner, and Bro. Leo, South Bend, Ind.; Jason Woodman, Kalamazoo, Mich.; and Judge Frank Williams, Allegan, Mich., for placing their farms and their experience at his disposal as a source of information. Further acknowledgment is due a large number of farmers on these sandy lands who have carried out work at the writer's suggestion.

supplies, meat, etc., for family use. Steps should be taken to make the farm as nearly self-supporting as is practicable, in order that living conditions may be more favorable when years of crop shortage occur.

In undertaking to develop one of these sandy-land farms due consideration should be given to the fertilizer requirements of the soil. In general, however, the use of commercial fertilizers should be postponed until soy beans or cowpeas have been grown on the different fields as the first step in soil improvement. All fertilizer elements give much greater returns after this is done.

Nitrogen and organic matter are of first and perhaps greatest importance in the building up of these lands. For this reason the growing of such crops as soy beans, cowpeas, and vetch is the first step that should receive attention. This alone gives surprising results in increasing crop production.

Phosphorus is the second element of fertility in these sandy lands to receive consideration. However, all forms of phosphate are unprofitable until these soils have been built up somewhat in nitrogen and organic matter. Much better returns for the money invested will be secured if the application of phosphorus is postponed until the much-needed nitrogen and organic matter have been materially increased. If quicker returns are desired the application may be made with a heavy green crop plowed under.

Lime should receive third place in relative importance as an element which these lands need. Ground limestone and marl are presumably the best forms of lime for agricultural purposes, but making light applications of burnt lime with the grain drill is gaining some favor. The application of lime is of about equal value at any stage of the soil-improvement program. It may well be the first step if sufficient means are available, but this is not necessary. It should, however, precede all attempts to grow clover or alfalfa.

Potash is of least importance as an element to be supplied to these sandy lands, but on farms which are extremely run down this step should not be overlooked. Where experiments were conducted under these conditions potash gave good results and greatly increased the value of phosphorus when the two were applied together.

The very common practice of allowing fields to remain idle for one or more seasons is a highly inefficient method of soil management. On some areas of these sandy lands this wasteful practice has become so prevalent as to demand serious consideration. Instead of allowing these fields to grow up to weeds or remain bare and exposed to the sun, it would be much better for the soil, and generally more profitable, to sow soy beans or cowpeas.

Live stock should become a feature in the development of these sandy-land farms as soon as conditions will warrant it and insure a

profit. The first reason for introducing live stock is to make provision for feeding soy beans and cowpeas and thus guard against a possible slump in the price of seed from these crops when seed production becomes more thoroughly developed. The second reason is that in addition to adding greater diversity of income and greater stability to the farm system, live stock, if made profitable, will furnish a much-needed means of profitable employment on the sandy farms of the area during the winter months.

Dairying is one of the first and most natural lines of live-stock farming to suggest itself on the sandy-land farms which are suitably located with reference to milk markets or shipping stations for cream. This bulletin gives only the preliminary steps for starting such farms. Soy beans and cowpeas for hay, with the possible addition of Sudan grass for hay, make it possible to start this industry with little expense. Brome grass (*Bromus inermis*) bids fair to supply the urgent need of a good summer pasture grass.

Hog raising, either alone or with dairying, is feasible on these lands as soon as the soil will produce 30 to 40 bushels of corn per acre with reasonable certainty. This industry requires less consideration of the distance of the farm from market. Field peas, commonly known as Canada field peas, grown to hog down, and soy beans—either for pasture when in blossom or for hogging down when ripe, or for winter feed, fed as hay out of the stack or from the barn—are each a valuable factor in the economic production of pork on these sandy-land farms. This bulletin gives preliminaries only.

On the west side of Michigan the northern limits of the sandy areas under consideration include the greater part of the sandy lands of Allegan County, except the lighter sands of the extreme western and northwestern parts; and on the east side of the State the most northern limits cover the limited areas of Oakland and Macomb Counties; but, as a whole, the plans outlined in this bulletin do not apply to sandy lands farther north than these arbitrary boundaries. In no case should this bulletin be so construed as to include the sandy "pine plains" or "Jack pine lands."

LOCATION OF THE SANDY AREAS.

The sandy lands of this general and widely extended area do not occur in one continuous body. In Michigan the principal and most typical areas are in the southwestern part of the State, but the work on which this bulletin is based covers the extensive sandy-land areas in southeastern Michigan, and Fulton and Lucas Counties in Ohio. The central counties of southern Michigan are comparatively free from sandy lands, but where these occur the principles outlined in this publication apply with equal value.

In Indiana the northern tier of counties contains the largest areas of typical sandy lands in that State. In addition to this, sandy lands in smaller and less continuous areas, and generally of better quality, occur throughout the counties of Jasper, White, Pulaski, Starke, and Marshall; and in parts of Cass, Fulton, Kosciusko, Whitley, and Noble.

GENERAL CONDITIONS.

On much of the typical yellow and gray sandy lands of this region agriculture in general has been somewhat backward for a number of years. The farms as a rule have been under cultivation for a comparatively long period. The sandy soils have been free to liberate the elements of fertility, which have been gathered in crops and sold off with no provision for keeping up production. The period of heaviest crop yields and greatest prosperity has long since passed. Good houses and barns are still common, but these often tell only of former thrift. In many instances yields have been so reduced that the average farm now fails to pay a reasonable income and often affords the owner and his family little more than a mere living.

Fences in general are poor. This makes it almost impossible to keep the smaller classes of live stock out in the fields. Consequently such live stock as sheep and hogs are few in number. What few are kept are confined to relatively close quarters. Generally only enough hogs are raised to furnish meat for the family. Occasionally a few are butchered for sale in the nearest home market, but seldom more than four or five per year. The live stock, therefore, on the average farm is very limited.

There are no very definite systems of farming established on these sandy-land areas. Different crops are grown and sold on the market, but a fixed rotation is rarely practiced. In changing crops from field to field, clover is necessarily omitted because of the very great uncertainty of this crop on these lands under present conditions. Cowpeas are taking the place of clover, but as yet not to the extent of being a part of a regular rotation. For the most part the crops are corn, wheat or rye, and some oats. After several years of cropping the fields in turn lie idle without cultivation and grow up to weeds. Idle fields left in this condition are numerous, and these at times give the sandy-land areas of this section rather a neglected appearance.

THE BIG PROBLEM.

Under present conditions the most difficult problem in connection with these sandy lands is not to outline minutely the conditions which prevail, discover the needs of the soil, nor point out the faults of present farm practice and suggest farm systems which

will be ideal after these farms have been built up and made productive. The greatest difficulty lies in the start. The real problem is to find a practical plan whereby a man on a poor farm, and with limited means, may begin at once to make a profit, and from this build up the farm and develop a well-balanced and profitable farm system. It is comparatively easy to suggest remedies and to point out what should be done, but it is quite another thing to make the money on a poor farm to follow out these suggestions. It costs money to buy the fertilizing elements and lime which may be needed. It is expensive to grow crops and plow them under. It takes real cash to pay for fences which will turn live stock. There must be something to yield an immediate and fairly certain and continuous income. How to get this out of a depleted farm, and at the same time build it up, is the big problem on these sandy-land areas.

SOY BEANS AND COWPEAS.

The key to the situation as here proposed lies in the production of soy beans and cowpeas, first for sale as seed and later as feed for live stock. These crops, under present conditions, offer the quickest and surest source of income on the sandy-land farms of the area, and make it possible to start the poorest of these farms toward a distinct betterment, while affording a reasonable income to the owners. From this beginning it is possible to introduce other suitable enterprises, including live stock, and thus to establish well-balanced and profitable systems of farming which are more general and diversified in nature and more certain of continuous income.

While similar in many ways, each of these crops has some points of advantage over the other. In the beginning, cowpeas require less attention than soy beans. Throughout the entire extent of these sandy lands it has not been necessary to inoculate cowpeas; whereas it is highly necessary to inoculate soy-bean seed in order to secure good results on new fields. This, however, is a simple matter. Inoculating material, with full directions, may be secured free of charge on request to the United States Department of Agriculture, at Washington, D. C. Small sacks containing about one quart of inoculating soil¹ may generally be obtained from farmers who grow the crop for seed. These may be shipped by parcel post or by express at a very small expense. Another apparent advantage of cowpeas over soy beans is that cowpeas are generally sown broadcast with the grain drill, either leaving all the holes open or stopping up every other one; whereas soy beans should be sown in rows about 32 inches apart

¹ The seed may be inoculated by stirring enough inoculated soil in milk-warm water to make it thoroughly muddy and sprinkling this over the beans a few hours before starting to sow them. An application of 300 to 500 pounds of inoculating soil per acre is effective, but in general the advantage does not justify the extra labor and expense.

and should be cultivated. After the inoculation is thoroughly established, fair success may be obtained with soy beans sown broadcast, the cultivation of the crop being done entirely with the spike-tooth harrow, but this method is uncertain at best and the crop often suffers greatly from weeds.

Thrashing cowpeas is much more difficult than thrashing soy beans. It requires special machinery to thrash cowpeas successfully; but the ordinary separator will thrash soy beans, provided a few minor adjustments of the pulleys are made to allow the cylinder to turn at a slower rate than for wheat or oats and still keep up the speed of the remainder of the machinery.

Both crops make excellent hay, which is valuable for feeding live stock. Soy-bean hay, which contains the ripened beans as well as the leaves, is about equal to alfalfa. Cowpea hay ranks lower in feeding value, but if cut when mature it compares very well with clover.

When ripe, each crop may be gathered by hogs or "hogged off"; but only the soy beans can be used successfully for hog pasture or forage. Hogs will eat the green leaves of the soy-bean crop at any stage of its growth, but ordinarily will not eat cowpeas in this manner, simply eating the pods of the cowpeas when ripe. On the other hand cowpeas are generally preferred for pasturing cows. This practice is gradually spreading, and it is now very common to sow cowpeas regularly for the double purpose of pasturing and improving the land. Thus, while both crops are valuable, and are similar in nature and cultural requirements, each has its distinct place of importance and bears a slightly different relation to the general problems to be dealt with. Everything considered, on these sandy lands the soy bean is the more valuable crop of the two.

SEED PRODUCTION.

The two crops of greatest value in beginning the work of improvement on any and all farms on these sandy-land areas, and which fill the most rigid requirements as cash crops, are soy beans and cowpeas for seed. Under all the conditions found these crops may be grown profitably at once, without expensive fertilizers, and may be made most effective in the important work of soil improvement.

Since both crops grow successfully on the poorest of these sandy farms without fertilizers, the start may be made with very little expense except for seed. The income that may be expected for the first two or three years will be about the same from cowpeas as from soy beans; but after the soil becomes thoroughly inoculated for soy beans this crop will do much better than cowpeas. The yields from each will vary greatly according to the productiveness of the soil. The variation runs from 5 to 20 bushels per acre, with 12 bushels

as a very good average. Some of the best growers have been able to average 15 bushels, with a maximum yield of 25 bushels per acre. So far \$1.50 to \$2 per bushel has been nearly a standard price, when sold on the local market, or to other farmers for seed. The demand has been good, both from local farmers and from seedsmen in South Bend, Ind., and Jackson, Mich., who supply the local trade and ship to other sections of the country where northern-grown seed is desired. Judging from other sections where soy beans are grown extensively for seed, prices may possibly drop as low as \$1 per bushel. Even this figure permits of a good profit on these sandy lands. It is easily possible for this section to establish a profitable



FIG. 1.—A good growth of cowpeas for seed production.

industry by growing a good quality of seed, both of soy beans and cowpeas.

Early varieties which have been grown in northern latitudes must be sown, in order to make sure that the seed will mature. The seeding for both crops should be done about June 1, and not earlier, as a rule, than May 25. During short seasons, such as 1915, late-sown cowpeas do not produce good crops of seed in this region. Under these conditions soy beans are generally better for seed, because this crop is injured less by early frosts. Of the varieties of cowpeas tested, New Era, Whippoorwill, and Groit have given best results. The Ito San variety of soy beans has been the most satisfactory. Some new varieties of soy beans brought from Manchuria by the United States Department of Agriculture are giving promise of even

better yields than any of the older varieties so far tried out. It is highly important in an enterprise of this nature that the growers of each section grow the same varieties and standardize their products, so that uniform carload lots may be put on the market.

The illustrations (figs. 1 and 2) give a good idea of the success with which these crops are grown on these sandy lands, as well as something of the difference in methods used in growing each.

The crop of cowpeas shown in figure 1 was grown near Granger, Ind., on poor sandy land with the application of about 300 pounds per acre of a fertilizer containing 2 per cent nitrogen, 8 per cent phosphoric acid, and 10 per cent potash. This amount of fertilizer



FIG. 2.—A good crop of soy beans growing on sand, showing the rows and method of cultivation.

is more than it would be profitable to apply under average conditions, and the per cent of potash is probably higher than is necessary. Five per cent of potash generally gives good results, but even this amount is prohibitive under the extreme conditions of 1915 and 1916. Unfortunately there was no machine available to thrash this crop and no data were secured as to yield. It may be said, however, that this is a better crop than should be expected under average conditions throughout the area without the aid of liberal amounts of fertilizer.

The soy beans shown in figure 2 are not mature; hence the illustration does not show this crop to the best advantage. However, it shows a vigorous growth, well advanced for the season, which later

produced a splendid crop of seed. The soil in figure 2 is a fine sand, naturally poor, but not seriously run down. This is the second year for soy beans on this field, and the growth is much better than it was the first year, on account of the soil being more thoroughly inoculated and the nodule development on the roots much more perfect. The third year the crop is generally better than the second for this same reason, and because of the available nitrogen in the soil from the roots of the two previous crops. After the second and third year the addition of phosphorus and potash becomes very effective in further improving the soy-bean crop or in growing larger yields of other farm crops.

While the business of growing soy beans and cowpeas for seed affords the best means of immediate returns in beginning the process of farm improvement on these sandy farms, this industry may well be continued as a part of a more diversified farm system when other cash crops may have been added and when the soil has been built up. In many instances potatoes may be grown to advantage after the land has been sufficiently improved, but not under the average soil conditions which exist at present. Vetch, also, when sown with rye, may be made a profitable cash crop, if a suitable machine is available for separating it from the rye. A gravity machine is being used successfully for this purpose in several counties in southern Michigan. For the first few years, however, more attention should be centered on soy beans and cowpeas for seed, and from this further progress may be made gradually until the stage is reached when it is wise to introduce more or less live stock.

THRASHING COWPEAS.

One of the greatest drawbacks to a rapid development of the cowpea seed industry on an extended scale is the difficulty in thrashing the crop. An ordinary thrasher will not do the work satisfactorily. The pods are very tough, and the vines generally wrap around the cylinder, thus choking the machine. What peas are thrashed out in this way are very badly cracked and broken. The only solution thus far found for this problem is to get special machinery for this purpose. On these sandy lands it has been necessary to do this in order to place the cowpea-seed industry on a footing that will make it profitable, and at the same time make it one of the definite stepping stones to the improvement of the soil and to better systems of farm management.

After considerable experimenting, a machine was found that does the work in an ideal manner, and yet sells at a reasonable price. This type of machine costs \$350, and the freight to most points in the area is about \$50 additional. This puts the outfit within reach of a community of farmers; and no doubt as the acreage of cowpeas in-

creases men who make a business of thrashing will add a similar machine to their equipment.

The main feature of a cowpea and bean thrasher of this type is the cylinder, which is very strong, and has sharp, knifelike teeth. The concave teeth are also of a special design, a part of which are sharp and similar to those of the cylinder. This arrangement makes it possible to thrash cowpeas without cracking more than 1 per cent, and at the same time it shreds the pods and vines perfectly. Such an outfit is not necessary for thrashing soy beans, but it handles this crop equally well. Figure 3 shows this machine in operation.

The illustration in figure 3 gives a fair idea of the efficiency of this machine. It is of good capacity, and is being operated in this instance by a 5-horsepower gasoline engine. To get the best results



FIG. 3.—Thrashing cowpeas, Granger, Ind.

under all conditions an 8-horsepower engine would be better. This outfit has been in use for three years. The first season it thrashed 200 bushels of cowpeas in small jobs on near-by farms, the second 1,000 bushels, and the third 1,500 bushels, and could not get to all the jobs that were available. This shows the increase in the acreage of this crop since this machine has been placed at the disposal of the farmers of that immediate community.

ALFALFA ON THE SANDY LANDS.

In working out farm problems and systems of farm management for a related agricultural area the question naturally arises: What place has alfalfa in the general scheme? It may be said that on small acreages here and there over these sandy lands alfalfa is growing

successfully. This, however, has not come about by careless methods, nor without considerable effort. There is a certain line of procedure necessary in nearly all cases. An application of from three to five tons per acre of either limestone or marl is the first important step. When marl may be had cheaply much heavier applications will prove profitable. It is better, also, to have grown soy beans on the land for two years previous to the first trial with alfalfa, to afford a good supply of available nitrogen to force the growth. Then, a rather heavy application of manure is a good thing, but not always necessary for success. August 1 has proven the most satisfactory time for sowing the seed, although some few have had excellent success by sowing very early in the spring, or about as soon as the frost is out of the ground. Inoculation is always necessary for complete success. The best and most reliable method for these sandy lands, as determined by actual farm practice, is to sow broadcast from three to five tons of inoculated soil per acre and harrow the surface thoroughly. This soil should be taken from a sweet clover patch, or from an old alfalfa field where the alfalfa is known to have the nodules well developed on its roots. If this method is impossible the alfalfa seed may be inoculated either with a small amount of soil or by artificial cultures furnished by the State or the United States Department of Agriculture. If the soil is well limed any of these methods should be effective.

While the lower depths of the soils of these sandy areas are doubtless deficient in lime, yet, if the first 8 or 10 inches of the surface is thoroughly limed, this deficiency in the subsoil proves no hindrance to the growing of alfalfa, since it is in these first few inches of depth that about all the nodules are formed on the roots, even under ideal soil conditions.

The sandy lands of northern Indiana and southern Michigan are not naturally well adapted to alfalfa, but if proper methods are followed, and the required amount of labor and expense is given, this crop can be successfully grown throughout practically the entire extent of these lands. The start should be made with only a small acreage, which can be extended later as the grower sees fit and as his experience broadens.

VETCH AS A FARM CROP.

Vetch so far has not received the wide recognition throughout these sandy-land areas which it deserves. Under conditions which prevail, vetch is much more uncertain than soy beans or cowpeas. This uncertainty, together with the prevailing high price of seed, has greatly hindered its introduction. The first few attempts on the poorer sections of the sandy-land areas are generally failures. To make sure of success from the very beginning manure is generally necessary. This

is not often available, especially in large quantities. Inoculation is also essential if the full value of the crop is to be realized. When grown successful for seed on these sandy lands, vetch becomes a very profitable cash crop. Other than this its main value is that of a crop to plow under to enrich the soil.

In growing vetch for seed it is necessary to grow it with some crop like rye to prevent it from lying flat on the ground. Until recently the greatest objection to this was the difficulty of separating the two so that the vetch seed may be sold on the market when thrashed. Now, an inexpensive gravity machine is available which does this work very effectively. Full information concerning this device may be secured by writing the Bureau of Plant Industry, United States Department of Agriculture, Washington, D. C. As a source of cheap seed for farm use each year, a small acreage may be sown with vetch and rye seed mixed. This mixture, which may be thrashed and sown again without any necessity of separation, will thus furnish the seed for the following crop.

For the first trial with vetch, a small field should be plowed about the middle of July and made ready for sowing the vetch and rye about August 1. In preparing the seed bed, a light application of manure should be worked into the surface of the soil. This, and the inoculation of the vetch seed, will generally insure success under very unfavorable soil conditions. Each year the crop grows on the same land the inoculation becomes more thorough and the growth better. Applying on each acre from 300 to 500 pounds of soil from a well-inoculated vetch field and working it into the surface thoroughly is perhaps the most effective method of inoculation, as soon as this is possible. After all the fields of a given farm will produce vetch successfully the vetch and rye seed may well be sown in the standing corn. This may be done by sowing the seed broadcast and covering it with a one-horse cultivator, or better still, by sowing with a small grain drill which goes between the rows.

Since so much of the value of vetch depends upon the relative success with which it is grown, the details of managing this crop should be thoroughly mastered in the beginning. Farmers' Bulletins Nos. 515 and 529 will be helpful in this connection. These may be secured on application to the Division of Publications, United States Department of Agriculture, Washington, D. C. Although less certain than the soil method of inoculation, liquid cultures for inoculating vetch seed, with full directions, may be secured free of charge by applying to this department. To avoid delay, application should be made two or three weeks before ready to sow the vetch seed.

Where wheat is a regular crop in the rotation, vetch for seed should not be grown, as it is very difficult to separate it from the wheat.

Volunteer vetch will prove troublesome in the wheat fields, and on the better farms, where wheat growing is profitable, it is better to omit vetch as a seed crop and grow soy beans and cowpeas instead. Vetch may be grown on the same farm with wheat if the vetch is used as a catch crop and plowed under before the seed ripens.

Although somewhat uncertain on new fields for the first two or three trials, or until the inoculation becomes thoroughly established, vetch will grow successfully over most of the sandy-land areas, provided the details are well carried out in starting it on fields where it has not been grown before. If a small field is selected for the first trials and the crop grown for two or three years in succession on the same field the immediate results will be much more gratifying. The soil of this field will then be valuable as inoculating material in starting vetch on the other fields of the farm. Vetch is one of the best crops available for building up the nitrogen and organic matter of these sandy lands. With due consideration for the uncertainty in the first few attempts to grow this crop, its value should attract greater attention, and eventually it should hold a prominent place on the sandy farms of the area.

SUDAN GRASS.

Sudan grass is of very recent introduction in the area. Up to the present it has been grown only in small patches, but with considerable success even on rather thin land. From all indications its popularity should increase. It will doubtless become more or less of a factor in the development of a large number of farms on these sandy lands. On fairly good soil, or on land which has been built up somewhat, this crop produces large yields of hay which is greatly relished by all classes of live stock on account of its sweetness. Sudan grass belongs to the sorghum family, and, being rich in carbohydrates, it should be fed with some feed correspondingly rich in protein. If this precaution is not taken, much of its value is lost. When fed with soy bean, cowpea, clover, or alfalfa hay, it is especially valuable for dairy cows.

This crop draws heavily on the fertility of the soil, and it possesses no qualities for building it up, as do soy beans, cowpeas, vetch, or field peas. This should be considered and ample provision should be made for keeping up the fertility of the soil by growing legumes and by the addition of manure or fertilizers.

Sudan grass should be sown about June 1 in these sections. Usually it is sown in rows and cultivated. The principal reason for this has been the cost of seed, but recent prices make this unnecessary. There is no reason why this crop should not be sown broadcast with the grain drill when seed prices permit. When rightly managed, a small acreage of Sudan grass should prove profitable and desirable on a large number of farms throughout these sandy-land areas.

BROME GRASS.

To obtain suitable pasture throughout the summer season is a serious problem on these sandy lands. Everything considered, it is probable that brome grass (*Bromus inermis*) is the best grass available for this purpose. Its native home is on the sandy plains of Hungary. In the United States it has become important only in the dryer regions; but it is not generally known that this highly productive, nutritious, and palatable hay and pasture grass is well adapted to sandy lands in the more humid sections. It is almost entirely unknown in this immediate region, but in one instance in Kalamazoo County, Mich., it has been grown for 15 years on very sandy land and with highly satisfactory results. The main difficulty has been in securing brome-grass seed free from the seed of quack grass. This has prevented the further introduction of brome grass in that immediate section. Provided brome-grass seed reasonably free from quack grass can not be obtained from responsible local dealers it may be feasible to buy it in large lots from western farmers. It has been successfully produced by farmers in eastern Washington and on some of the extremely sandy soils in northern Minnesota. It gives considerable promise on the sandy land of this section and deserves a thorough trial, first as a pasture grass and second as a hay crop.

ROTATIONS AND CROPPING SYSTEMS.

Some definite plan for a succession of crops is essential in beginning the improvement of the sandy-land farms of this section, if the greatest possible progress consistent with reasonable profits is to be made. As the improvement advances through the various stages the needs of the farm will naturally suggest changes toward rotations better suited to the stage of development which has been attained. The first stage, being that of growing and selling cash crops, most naturally calls for as large an acreage of such crops as can be grown to advantage.

CONTINUOUS CROPPING WITH SOY BEANS.

Beginning with the initial stage of the plan of farm improvement, and with soy beans as the cash crop, a good system to follow for a number of years is to provide for producing relatively liberal amounts of corn and hay, and then to grow soy beans for seed over as much of the remainder of the farm as it seems wise to do under existing conditions, and on the same fields for two or more years in succession, simply alternating with a catch crop of rye. After the soy beans have been harvested each year the soil should be thoroughly disked and rye should be sown. Usually this will be rather late and the rye will not make much growth during the fall season, but it will come on well in the spring, and by May 25 will have

reached a splendid stage for a green-manure crop. At this time it should be plowed under in preparation for the next crop of soy beans.

The soy-bean seed must be thoroughly inoculated the first year; after that the crop improves from year to year as the inoculation becomes more thorough. This is the main reason for continuing the soy-bean crop for more than one year on the same land. In addition to this, plowing down the rye each year furnishes much needed vegetable matter which improves the soil greatly. Under normal conditions, commercial fertilizers may be used to advantage with this system after the second year. If raw rock phosphate is used it should be applied with the rye crop which is plowed under. After this system has been carried out for three years on a given field, other practices may be introduced and other crops grown which will form a more extended rotation.

The merits of this system of cropping, however, in beginning the improvement of the poorer class of sandy-land farms, can not easily be overrated. It yields a profitable crop for sale each year, and one also to be plowed under on the same land. Adding to this the amount of available nitrogen which the soy-bean crop adds to the soil, the general improvement is very rapid. A further step may well be taken by feeding the hay resulting from thrashing the soy beans and returning the manure to the land as soon as possible. If the hay is not fed it should be used as bedding and then scattered out over the rye during the winter and early spring.

Practically the same cropping system can be carried out with cowpeas for seed with about the same results, except there will be no improvement in the cowpeas due to better inoculation from growing the crop more than one year on the same land. In fact, it is better to change the cowpeas to a new field each year in a rotation with other crops.

TWO-YEAR ROTATION, INCLUDING CORN.

In many instances it may be more desirable to start with a definite rotation and make that rotation include corn as well as soy beans or cowpeas. The two-year rotation which will accomplish this best runs as follows:

First year	-----	Corn.
Second year	-----	Soy beans or cowpeas.

A catch crop of rye and vetch may well be sown in the standing corn, or rye alone after the corn is cut. This may be allowed to grow till about May 25, when it should be plowed under to prepare for a crop of soy beans or cowpeas to be grown for seed.

This rotation will gratify a very common desire to grow soy beans or cowpeas one year and the next year follow with corn. In this some caution should be observed. Such rotation may for a time in-

crease the yield of corn materially, but may eventually prove a means of further and more completely reducing the fertility of the soil. The crop of soy beans or cowpeas will add available nitrogen and this will stimulate the growth of the corn, causing it to take up greater quantities of the mineral elements of the soil. If, then, the corn crop is sold off the farm for a number of years, and no manure is returned to the fields, the results will be destructive rather than beneficial. This should be avoided as far as possible, and each year, in addition to plowing under the catch crop of rye and vetch or of rye alone, some fertilizer should be used with the special idea of keeping up the supply of phosphorus.

This rotation may be employed in connection with dairying if some provision is made for summer pasture, or without pasture if sufficient silage is produced to feed during the entire year. The growing of a small acreage of alfalfa may well be added also, if conditions will permit. This rotation may likewise be used in the early efforts with hog raising. It is best suited, however, to the system in which only one litter of pigs is raised each year, this being the late summer or early fall litter. In introducing live stock of any kind with this rotation, it is well to keep the cash-crop idea as the more important feature of the system until the process of the development of the farm is well advanced.

THREE-YEAR ROTATIONS.

The 2-year rotation just considered may easily be extended into a 3-year rotation. This can not be done, however, without sacrificing to some extent the opportunities of adding features of special value in soil improvement. As a 3-year rotation it would run in the following order:

First year	-----	Corn.
Second year	-----	Rye, or rye and vetch.
Third year	-----	Soy beans or cowpeas.

This arrangement would permit of harvesting three different crops each year, and in respect to introducing greater diversity this is valuable. The extended period of rotation, however, permits the legume, either soy beans or cowpeas, to grow on the same field only once in three years, and in this way is less effective in adding nitrogen. The feature of having a catch crop of rye or rye and vetch to plow under in preparation for the soy beans or cowpeas may be retained by disking the field after the rye crop or the rye and vetch has

been harvested. There is always enough shattered grain to give a fair stand which will attain a good growth by May of the next spring.

Better suited to later stages of development of sandy-land farms in this region is the ordinary 3-year rotation with clover, arranged in the following manner:

First year	-----	Corn.
Second year	-----	Rye.
Third year	-----	Clover.

Before such a rotation can be put in operation, however, on the average sandy-land farm of the area, the soil must be put in good condition to grow clover. Generally this requires considerable time and some extra expense; but where the farm can best be managed in three fields, with possibly one or two smaller fields for pastures and lots, it might be well to begin at once and make ready for such a rotation, even if the immediate expense is greater. In this case one of the first steps should be to apply ground limestone on one of the fields immediately, or as soon, at least, as possible. This should be done during the winter or early spring, and it would be well to disk the surface afterwards, if sufficient time is available. During the latter part of May the field should be plowed, made ready, and sown to cowpeas. About August 1 the crop of cowpeas should be plowed under, the land thoroughly prepared, and sown to clover. The clover seed should be sown alone and covered by harrowing. The next season a fairly good crop of hay ought to be produced, and possibly a second crop to be plowed under if desired, or to be cut for seed or hay. Each field should be handled in this manner in succession until the entire farm will grow clover successfully.

It should be kept distinctly in mind, however, that this applies to the sandy-land areas only. Seeding clover in the late summer or early fall on heavy silt or clay loam soils is a very doubtful practice; but on these sandy lands August 1 to 15 is one of the best seasons for clover seeding, if not the best beyond question.

A practical modification of the 3-year rotation of corn, rye, and clover may be carried out under the average conditions of these sandy lands. A part of the cornfield may be set aside for soy beans or cowpeas, preferably soy beans. Corn may occupy two-thirds of the field and soy beans for seed may occupy the remainder, or the two crops may be grown in such proportions as conditions may warrant. On the part of the field devoted to corn, at the last cultivation soy beans may be sown ahead of the cultivator. This will extend the beneficial effect of the soy beans over the entire field, but it will be too late to mature seed on the part of the field where soy beans are sown in the corn at this time.

FOUR-YEAR ROTATIONS.

A 4-year rotation of special merit with reference to improving sandy-land farms may be outlined as follows:

First year.....	Corn.
Second year.....	Soy beans.
Third year.....	Corn.
Fourth year.....	Cowpeas.

With this arrangement the usual catch crop of rye or rye and vetch may be sown in both the first and third year corn, to be plowed under in preparing the land for the soy beans of the second year and the cowpeas of the fourth year. If it is thought desirable a part of this rye may be left to ripen to furnish seed and straw for bedding. The character of this rotation in general is such as to make it more suited to the first stages of development and reorganization of the average farm of the section.

After the first stages of development have been passed—which should include the application of limestone or marl—and clover can be grown with reasonable certainty, it is more logical to shift gradually to a 4-year rotation of this character:

First year.....	Corn.
Second year.....	Soy beans or cowpeas.
Third year.....	Rye.
Fourth year.....	Clover.

Generally speaking, this rotation presupposes that from 2 to 3 tons of ground limestone or marl per acre have been applied to the entire farm, or that one field, at least, has received such an application and that a new field will be thus treated each year before an attempt is made to seed it to clover.

The value of the catch crop of rye or rye and vetch should not be overlooked even after reaching the point where this rotation can be put in operation successfully. This should be sown in the first-year corn or after it is cut, and should be plowed under about May 25 to prepare for the second-year soy beans or cowpeas.

As the development of the farm demands it, the corn-crop acreage may be increased conveniently. This may be done by planting corn in a part of the soy-bean or cowpea field. In this case it would be well to sow an early variety of soy beans broadcast in the corn immediately ahead of the last cultivation. If inoculation has been furnished, this will still give the second-year field of the rotation the benefit of having a legume grown on the entire acreage. As another modification which may be desirable under some conditions, wheat may be substituted for rye in the third year of the rotation. Not until the soil has been well built up should such a change be con-

sidered; for in general on these sandy lands rye produces better than wheat.

With some provision for permanent pasture, this rotation is well suited to a combination of cash crops and dairy farming. It is better suited to hog raising than the 3-year rotation of a similar nature, because the corn crop may be extended to a relatively greater acreage as compared with the other crops.

FIVE-YEAR ROTATION.

In some cases, when it seems wise to grow more corn for feeding live stock than is provided in the shorter rotations and where conditions favor such a plan, a 5-year rotation may be desirable. Everything considered, the following is the most logical:

First year.....	Corn.
Second year.....	Soy beans or cowpeas.
Third year.....	Corn.
Fourth year.....	Rye.
Fifth year.....	Clover.

This rotation is suited to the more advanced stages of development of the sandy-land farms of the section. Including clover as it does, the fields must have received the usual application of ground limestone or marl, in order to insure success with this crop. If soy beans have been grown on these fields for several years previous to this application, conditions will have been made still more favorable. Notwithstanding the greater productiveness of the land which this rotation requires, advantage should still be taken of the opportunity to grow a catch crop of rye or rye and vetch in the first-year corn to be plowed under to make ready for the soy beans or cowpeas of the second year. This feature will strengthen the rotation greatly and add much to its general effectiveness.

SIX-YEAR ROTATION.

One of the more desirable plans for a 6-year rotation is to allow the clover of the 5-year rotation to stand 2 years. This can be done by not allowing it to produce seed the first year, or by sowing timothy with the clover and allowing this to be the dominating crop the second year, and to be cut for hay or used for pasture. Pasturing is more in keeping with soil improvement, together with reasonable profit and a good distribution of labor. This, as well as the 5-year rotation, might well be used in connection with dairying or hog raising, together with cash crops, or a combination of all three.

FIVE-YEAR ROTATION, INCLUDING POTATOES AND VETCH.

This rotation, or some modification of it, is being advocated for many southern and central Michigan sandy farms. It is rapidly gaining prominence on the broad sandy-land region farther north

which borders Lake Michigan. In that section it will doubtless be applicable farther north than the rotations which include soy beans and cowpeas as a seed crop. The full rotation is arranged in the following order:

First year.....	Vetch and rye.
Second year.....	Potatoes.
Third year.....	Rye.
Fourth year.....	Clover.
Fifth year.....	Corn.

The vetch crop in this rotation is grown with rye for seed. In harvesting these crops there is always more or less seed which has shattered out on the ground. By going over the field with the disk the most of this is covered and a good stand of volunteer vetch and rye is secured, which is permitted to grow until a short time prior to the first of June of the next year, then is plowed under before planting the potatoes. This is a valuable feature of the rotation which is secured with very little labor and expense. It is a big factor in the production of the potato crop, as well as in the improvement of the soil.

This rotation, likewise, fits in well with the plan which has been kept in mind throughout this work, namely, immediate profits and the improvement of the general farm conditions. It includes two cash crops, vetch seed, and potatoes. Rye also is a fairly profitable crop when sold on the market. The item of soil improvement is provided for with the vetch and clover and the heavy growth of volunteer vetch and rye to be plowed under. Serving as a balance to the rotation, the corn and clover will take care of a limited number of live stock and thus become valuable as feed crops.

SOIL REQUIREMENTS OF THESE SANDY-LAND AREAS.

The soil of these areas varies somewhat, but as a whole is very sandy. The surface is generally a very light gray to whitish-gray sandy loam, in many instances becoming almost pure sand. The subsoil is a yellow sandy loam, with a large percentage of sand and some gravel. This makes a subsoil which is rather porous and affords quick drainage, but naturally the effect of manures and fertilizers is not so lasting as on soils with a clay subsoil. However, these sandy soils as a whole respond readily to proper treatment.

NITROGEN AND HUMUS.

The needs of these soils are many and urgent. One of the first, and possibly the greatest, is that of nitrogen and decaying vegetation, or humus-forming material. This is apparent to the most casual observer. Very light applications of nitrate of soda show a remarkably good effect on the leaf development of all crops. The

growing of soy beans and cowpeas, especially if these are turned under, greatly increases the yield of succeeding crops. The application of straw or vegetable material of any kind gives an immediate benefit.

Although the soils are quite sandy, after heavy rains it is very common for a distinct crust to form on the surface, which must be broken up by thorough cultivation in order to conserve moisture effectively. As legumes are grown, and crops or crop residues are turned back into the soil, this tendency disappears, the nitrogen is increased, and much improvement is noted in crop growth. This is the first and most important step in the improvement of these lands, and until this is done little result may be expected from other lines of treatment.

PHOSPHORUS.

After nitrogen, the next need of these sandy soils to be considered is phosphorus. Information on this has been gathered from experiments conducted by the writer and from the experiences of many successful farmers in the region who have been cooperating in the work. Where phosphorus has been applied in the form of common acid phosphate, it has always given results that have been plainly visible, but the best results have been secured after nitrogen has been increased in the soil and when the phosphorus has been applied in connection with potash. However, on the better class of farms, where the land is of a little heavier nature, phosphorus alone gives very satisfactory results. The improvement which has been obtained from the application of one-half ton of fine ground rock phosphate per acre, together with the plowing under of green crops or manure, also speaks well for this method of soil treatment; but when raw rock phosphate is applied alone on very poor sandy lands of the area, even at the rate of a ton per acre, it has made a very poor showing. Practically all of the sandy land of this region will be benefited greatly by the use of phosphorus, especially if used in connection with green crops plowed under or with manure, or after available nitrogen and vegetable matter have been increased somewhat by growing soy beans or cowpeas.

POTASH.

There is a wide difference of opinion throughout the area as to the necessity of applying potash to these soils. On the better farms, where the soil has been kept up fairly well, there is not so much need of this element; but throughout the experiments by the writer, especially on the poorest of the sandy lands, potash gave very good returns, and greatly increased the effect of both nitrogen and phos-

phorus when used in connection with these two elements. The results were so marked that there can be little question as to the value of potash on most farms on these sandy-land areas, especially where the soil is much depleted. Since the conditions vary somewhat with regard to this element on different farms, it would be well for each farmer to do some experimenting with it.

LIME.

The lack of lime in these sandy soils is becoming generally recognized over the entire section. The great value of finely ground limestone and of marl is very evident in connection with the growing of clover and alfalfa. There are a few farms, which have been kept up by special effort in the way of hauling manure from outside sources, on which clover still can be grown fairly well; but on the average sandy farm of the area the clover crop is extremely uncertain and generally out of the question, even with special care in seeding. Nearly all clover fields are spotted and uneven. Large areas turn yellow, finally die out, and give way to a thin growth of weeds. These results are about the same when clover is sown alone and given the best possible chance to thrive, but with no lime applied.

From the results obtained from the application of limestone and marl on a large number of sandy farms over the general area, there can be little doubt of the extreme value of this practice, especially on farms which are considerably run down. Practically all such farms in the area need lime badly, and even on farms which are in better condition experiments should be made with limestone where there is any difficulty in growing clover successfully. Fortunately, in many localities marl beds have been found from which marl may be had locally for less money than ground limestone, and it is equally effective.

Under average conditions on these sandy lands no attempt of any importance should be made to grow alfalfa without the application of from 2 to 3 tons of ground limestone or marl per acre, and because of such a great and general need of lime in the entire area practically the same may be said in connection with clover.

THE IDLE FIELD.

Fields left idle to grow up in weeds for one or more years are of very common occurrence throughout the area. When the fertility of the soil reaches an extremely low point these fields are turned out to allow nature to improve them temporarily by whatever increase of vegetation may accumulate from the growth of weeds, grass, etc. Very often it happens, however, that the soil has been so reduced in fertility that even the weeds can make only a scant growth. The

results at best are not good. Notwithstanding this, considerable importance is attached to the practice, and when the time arrives to put in another crop, whatever weeds, old stalks, etc., may have accumulated are plowed under, and generally either wheat or rye is sown. After the wheat or rye is taken off the field is left idle till the next spring, when it is plowed again and corn is planted. Thus the cropping system is wheat and corn or rye and corn, with an occasional period of one or more years for the fields to remain idle or uncropped.

Such a system is unprofitable in that the fields yield no income during the idle period, and the slight increase in yield, which results from the land remaining uncropped for a time, does not compensate for this loss. Aside from incurring a loss in this way, an opportunity is missed for growing a crop of soy beans or cowpeas which would be profitable and at the same time improve the soil conditions much more rapidly than this period of inactivity can possibly do. While there is an apparent increase in production by allowing a field to remain idle, there can be no permanent improvement in a cropping system built principally on this idea.

In the long run such a system is very harmful. As generally managed it is one of the surest ways to reduce the productiveness of a farm that can be devised. Throughout the hot growing season there is little protection for the uncropped fields. Because of the sandy nature of the soil, much heat is absorbed and a greater proportion of the organic matter remaining in the surface is burned out and rapidly consumed. Much of the nitrogen liberated by this process is lost because there is no crop on the land to take it up and use it. These sandy lands are very deficient in nitrogen and organic matter already, and it takes special effort in this direction to keep pace with the amounts consumed by ordinary cropping. With the present system this condition is rapidly made worse instead of better. The soil still further loses its power to retain moisture for crop growth and has a greater tendency to crust after rains. The idle field gains little and loses much.

This injurious practice should be supplanted by one that will have an entirely opposite effect. Rye and inoculated vetch seed, or rye alone, should be sown in the corn fields about the middle of August. These crops should be allowed to grow until about May 25 of the next season, and then should be plowed under to prepare for sowing a crop of soy beans or cowpeas by June 1. If this practice were substituted for that of allowing the fields to be idle and grow up to weeds, it would return greater profits, and a great step would have been taken toward the improvement of farm conditions throughout the sandy-land areas of the entire section.

THE INTRODUCTION OF LIVE STOCK.

While it is highly desirable to start the improvement of most of these sandy-land farms on more of a cash-crop basis, it is, indeed, unwise to plan to exclude live stock indefinitely. The experience of other localities where soy beans or cowpeas are grown extensively for seed is that the price holds up well so long as the local demand absorbs the local output, but when it becomes necessary to ship to get a market, the price declines to about \$1 a bushel and remains fairly steady at that level. The demand for early varieties and northern-grown seed may prevent this to some extent in this section, but the presumption is that the present high price for soy-bean and cowpea seed will not prevail in the region long after local demand fails to take care of local supply. It is practically certain that if the production of soy-bean and cowpea seed for sale were to become general over all of the sandy-land areas of the section, the present very attractive price received will eventually fall quite materially. As this stage of development is approached live-stock farming will become more of a necessity. In this case soy beans and cowpeas should still be grown, but to a greater extent for feeding live stock.

There is likewise a great need of live stock as a means of furnishing profitable winter employment on the average farm of the region. This being a northern latitude, very little productive winter work is available on the farm, except as it comes about in connection with the feeding and caring for some kind of live stock. But there should be no immediate haste to get away from the more strictly cash-crop stage and rush into live-stock farming. Sufficient money should be made while on the cash-crop basis to purchase fences suitable for turning live stock, and not until several fields are well fenced should much live stock be kept. Then, too, the soil must be built up to a point where an abundance of feed can be grown. Live stock should come in gradually and in its proper relation to a carefully developed plan.

THE DEVELOPMENT OF DAIRY FARMS.

There are a number of features which tend to make dairying one of the first types of live-stock development to be considered on the sandy-land farms which are favorably located for this industry. It is much easier and cheaper to fence against cattle than against most any other class of live stock. Two or three strands of barbed wire well stretched will furnish a good fence temporarily for cows that have plenty to eat. On many farms this alone will be an important factor in deciding the trend toward dairy farming. Dairy cows also will consume profitably large quantities of roughage produced so readily on these sandy areas by growing soy beans, cowpeas, and

field peas. In this way soil improvement with these crops may continue even better than by seed production. Along with the hay made from these crops, especially that from soy beans cut when the leaves first begin to turn yellow, the addition of Sudan-grass hay furnishes a splendid combination of roughage which makes it unnecessary to feed much grain to dairy cows.

Under the conditions thus developed it is possible to start a dairy farm of simple equipment with small expense. In the beginning at least a silo is not necessary. Soy-bean and cowpea hay, together with Sudan-grass hay, will furnish practically all the feed that is needed. The milk produced on this ration will not be as great in quantity as on silage, alfalfa, grain, and mill feeds, but the cost of production will be much less. The results from this cheaper feed are such that it forms the most logical starting point for a dairy farm where only small capital is available. If, with this simple beginning, experiments with brome grass should add good summer pasturage, a splendid foundation will have been made for further developments, which in due time may include more expensive equipment, the growing of alfalfa, etc.

It is the plan of this bulletin to omit further details in the development of dairy farms in this area, the cropping systems, and systems of marketing. The entire scope of the dairy-farm problem under the sandy-land conditions is too broad to be covered in this bulletin.

THE INTRODUCTION OF HOG RAISING.

The question as to when to introduce hog raising in the farm scheme on these lands should be governed very largely by the progress made in building up the soil. As soon as 30 to 40 bushels of corn per acre can be produced with reasonable certainty, this step may well be considered. Success with clover is desirable also, but not entirely necessary. With corn, soy beans, cowpeas, field peas, and rye, cropping systems may be formed to suit the needs of hog raising on sandy farms in all parts of the area.

These crops and the general conditions which prevail make it advisable at first to raise only one litter of pigs per year. These should be late summer or early fall pigs, in order to avoid the period during midsummer, when, without clover, pasturage on the sandy lands is very scarce. For fall pigs rye pasture will be available till winter, and during the winter months corn, with soy beans fed as hay, will furnish an ideal ration. In the spring rye pasture is available again until May 1 to 10. After this time corn alone will compose the principal part of the ration until the hogs are sold on the market in late May or early June. This makes a very simple system

of hog raising and one which is especially adapted to these sandy lands and to the crops which can be produced without difficulty.

If two litters of pigs are raised per year a different plan must be followed, which in itself must be more complex and bring in several difficulties. Clover or alfalfa should be available for summer pasture. Without one or the other of these crops growing successfully there will be a break between the periods when pasture crops are available. The earliest pasture crop is rye, which becomes too woody for pasture purposes after May 10. Field peas sown early will be available about July 15 to 25. About this time also the ripened rye crop may be hogged down. Soy beans may be pastured as soon as in full bloom, which generally is about August 15, depending somewhat on the variety. Rape, too, will furnish an abundance of fall pasture. But during the period from May 1 to July 25 considerable quantities of grain will be necessary, unless perchance an abundance of skim milk is available to take the place of pasture. Hence, everything considered, under the peculiar conditions which prevail in these sandy-land sections, it is better to confine the earlier efforts at hog raising to the simpler system of producing only one litter of pigs per year.

The feeding of soy beans to hogs during the fall and winter seasons is perhaps one of the most valuable practices to be developed in connection with these sandy-land farms. The simplicity of the operations involved and the results secured are gratifying indeed. The soy-bean crop cut when the leaves first begin to turn yellow, cured, and stored or stacked as hay, and fed as such in addition to corn, gives almost the equivalent to the best summer-pasture conditions and eliminates almost entirely the necessity of buying high-priced mill feeds, tankage, etc. The only exception to this is feeding middlings to small pigs and tankage or meat meal to brood sows for about two months before farrowing. The beans are rich in protein (about 29 per cent), which is the element of food for growth. The oil content also is high, which in itself has a laxative effect. This, together with the large amount of leaves eaten, keeps the hogs thus fed in perfect condition for making the best gains possible. Soy beans fed after this plan make profitable pork production possible during the winter season. Since this scheme fits in so well with the conditions on the sandy lands of this entire section it is indeed important.

CONCLUSION.

The normal stages of development for the average sandy-land farm of this general section should be about three in number.

The first should be that of growing and selling cash crops, among which soy beans or cowpeas for seed should have a prominent place.

The second should be a transition stage, in which live stock is being introduced as rapidly as fences can be purchased and built, and as the farm can be made to produce the necessary feed and pasture.

The third stage should be that of a general and well-diversified farm system, with the proper balance between cash crops and live stock which will afford profitable employment for the entire year, maintain crop production in a reasonably high state, and yield a suitable labor income. -

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UNITED STATES DEPARTMENT OF AGRICULTURE



FARMERS' BULLETIN



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Contribution from the States Relations Service, A. C. True, Director.



FOOD FOR YOUNG CHILDREN.¹

By CAROLINE L. HUNT,

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Food for children between three and six years of age should be chosen with reference to their bodily needs, as described in the

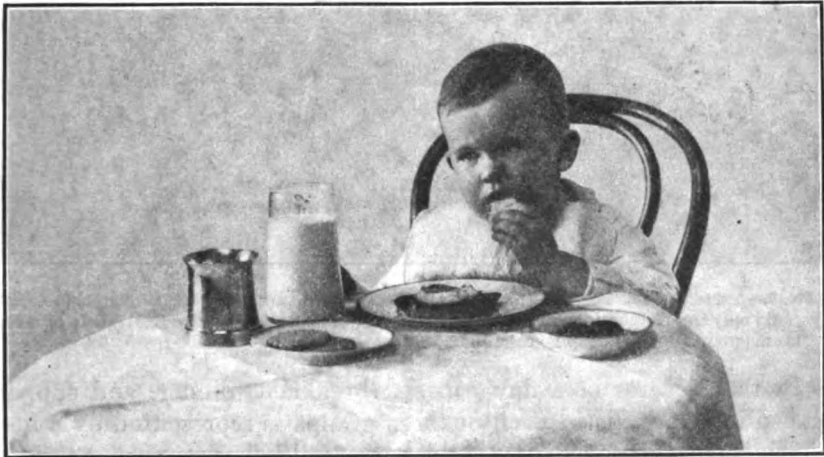


FIG. 1.—A healthy child having a sensible meal. Every child needs clean, wholesome food, well prepared, and served in quantity and variety sufficient for normal growth.

following pages, and should be carefully prepared and attractively served as shown in the above picture.

¹ Prepared under the direction of C. F. Langworthy, Chief, Office of Home Economics.

NOTE.—This bulletin is in accordance with the principles of child feeding now generally accepted by the best authorities, and also embodies the results of work done in the laboratory of the Office of Home Economics of the States Relations Service, U. S. Department of Agriculture. It is specially adapted to the use of mothers who wish some simple and short discussion of the subject expressed in housekeepers' terms.

INTRODUCTION.

A little child who is carefully fed in accordance with his bodily needs (as these are now understood) receives every day at least one food from each of the following groups:

1. Milk and dishes made chiefly of milk (most important of the group as regards children's diet); meat, fish, poultry, eggs, and meat substitutes.
2. Bread and other cereal foods.
3. Butter and other wholesome fats.
4. Vegetables and fruits.
5. Simple sweets.

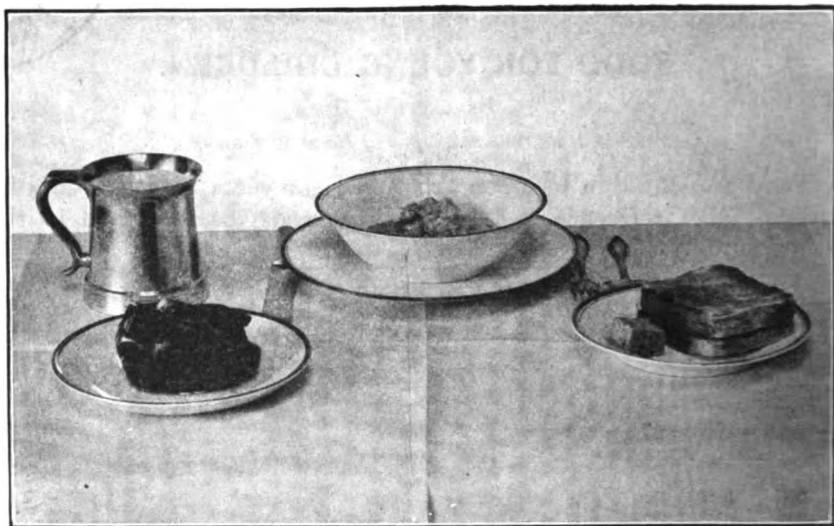


FIG. 2.—A sensible breakfast for a child. The breakfast shown consists of the following: Baked apple (pulp only for the youngest children and for those with whom the skin disagrees) (group 4); cereal mush (group 2); milk (group 1); toast and butter (groups 2 and 3).

In the pictures of a day's meals (breakfast, dinner, and supper) shown in this bulletin each of these groups is represented by a food which is suitable for a little child, each food being numbered to indicate the group to which it belongs. The purpose is to show a day's ration containing enough different kinds of foods to meet all the child's needs. The size of the portions would, of course, depend on the child's age. With usual quantities served the meals should be sufficient.

Many other meals might have been shown, for there is no food in the pictures, except milk, which could not have been replaced by some other wholesome food. Milk, if it can be procured, should form part of the food of every child, except when for some special reason the doctor objects, and this he seldom does.

The pictures may be helpful in preparing children's meals. The one on page 2 shows a breakfast, the one below a dinner, and that on page 5 a supper. The three together will supply food for a day in wholesome and suitable form. These meals are simple and such as a child should like. The quantity served should vary with the age of the child.

The picture of the dinner given below represents the heaviest meal of the three here shown. For little children it is usually considered wise to serve such a meal in the middle of the day rather than at night.

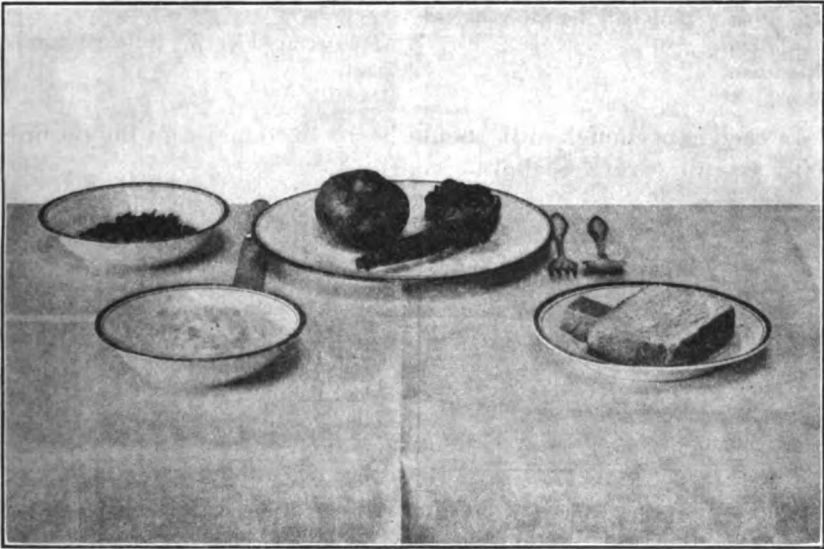


FIG. 3.—A sensible dinner for a child. The dinner shown above consists of the following: Lamb chop (group 1); baked potato (group 4); spinach (finely chopped for youngest children) (group 4); bread and butter (groups 2 and 3); rice with milk and sugar (groups 1, 2, and 5).

The picture on page 5 shows a well-chosen supper for a growing child. The foods are simple and simply cooked, but are the kind liked by most healthy children. As all the pictures show, the service is orderly and neat in every way. This is important because it helps to form neat and orderly habits.

The following bills of fare, like those in the pictures, are simple, easy to prepare, sufficiently varied, and, if well prepared, should taste good. They are so planned that milk and another food from group 1 and a food from each of the other groups will be served at least once a day.

SUGGESTED BILLS OF FARE.

BREAKFAST.

Orange (juice only for the youngest children).

Farina with milk.

Bread and butter.

Apple sauce.

Oatmeal with milk.

Toast and butter.

Baked pears (pulp only for the youngest children).

Milk toast.

Cocoa.

Stewed prunes (pulp only for the youngest children).

Corn-meal mush and milk.

Toast and butter.

Grape fruit (juice only for the youngest children).

Milk toast with grated yolk of hard-boiled egg.

Apple (scraped for very little children).

Toast.

Hot milk.

In each case enough milk should be given to make up the required daily amount, which is about a quart.

DINNER.

Meat soup.

Egg on toast.

String beans.

Rice pudding.

Roast beef.

Baked potato.

Asparagus.

Bread and jelly.

Lamb stew with carrots and potato.

Twice-baked bread.

Tapioca custard.

Creamed potatoes.

Green peas.

Stewed plums with thin cereal-milk pudding.

Baked halibut.

Boiled potatoes.

Stewed celery.

Boiled rice with honey or sirup.

Broiled meat cakes.

Grits.

Creamed carrots.

Bread, butter, and sugar sandwiches.

In each case enough milk should be given to make up the required daily amount, which is about a quart.

SUPPER.

Baked potatoes, served with cream and salt, or with milk gravy.

Cookies.

Bread and milk.

Apple sauce.

Sponge cake.

Potato-milk soup.

Twice-baked bread.

Marmalade sandwiches.

Graham crackers and milk.

Baked custard.

Milk toast.

Stewed peaches.

Cup cake.

Celery-milk soup.

Toast.

Floating island.

In each case enough milk should be given to make up the required daily amount, which is about a quart.

Though all the foods mentioned in the bills of fare may be included under five heads, the diet need not be monotonous, for many foods come under each class. The different groups are described in the pages that follow.

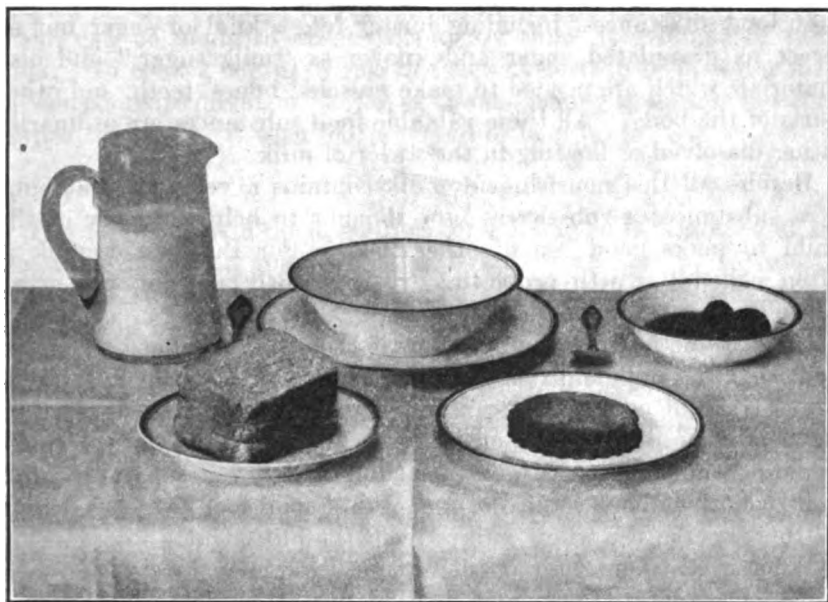


FIG. 4.—A sensible supper for a child. The supper shown above consists of the following: Milk (group 1); Bread (group 2); stewed prunes (pulp only for youngest children) (group 4); plain cookies (omit in case of youngest children) (group 5).

FOOD GROUP NO. 1.—MILK AND DISHES MADE CHIEFLY FROM IT; FISH, POULTRY, EGGS, AND MEAT SUBSTITUTES.

The different foods mentioned in the heading of this group have enough in common to warrant bringing them together. However, milk is such an important food for children that it is desirable to speak of it by itself.

MILK SERVED IN VARIOUS WAYS.

Milk is the natural food of babies and the most important food for young children. A quart of milk a day is a good allowance for a child. The greater part of this is usually given as a drink or served on cereals or in the form of bread and milk. Milk may also be served on fruits that are not very acid (baked apples or pears, berries, and others), in soups, gravies, custard, junket, and other puddings, and may be used in place of water in cooking cereals.

Milk, being a liquid, is sometimes classed with water, tea, and coffee, simply as a beverage, by those who do not understand its value as food. This is a great mistake. If all the water were to be driven off from a quart of tea or coffee, almost nothing would be left, and the little that remained would have little or no value as food. If, on the other hand, the water were driven off from a quart of whole milk, there would be left about half a cupful of the very best food substances, including butter fat, a kind of sugar not so sweet as granulated sugar and known as "milk sugar," and also materials which are needed to make muscles, bones, teeth, and other parts of the body. All these valuable food substances are ordinarily either dissolved or floating in the water of milk.

Besides all this nourishment, milk contains a very small amount of a substance or substances now thought to help the body of the child to make good use of other foods. For this reason milk is often called "growth promoting." Apparently nothing can serve so well as the basis for the diet of the healthy child.

Good whole milk is desirable, but if a mother is obliged to choose between clean milk and rich milk, she had better take the clean milk. Best of all, of course, is clean whole milk, but if that can not be obtained it is better to use clean fresh skim milk than dirty or questionable whole milk. A quart of skim milk, even separator skim milk, contains about a third of a cupful of solid food, which is nearly all there was in the whole milk, except the butter fat.

When it is absolutely impossible to get fresh milk, condensed, powdered, or evaporated milk may be used, but before doing this parents should try in every way to get fresh milk for their children.

Compared with most other foods milk contains much lime but very little iron. Spinach and other green vegetables and egg yolks are, on the other hand, very rich in iron. This is one reason why combinations of egg yolks and milk and of vegetables and milk are mentioned so often in this bulletin.

When milk is given to babies the chill is usually taken from it. It is safe to do this for all young children. When milk is used as a drink it should be sipped, not gulped down.

Besides being served as a beverage, milk is often combined with many other foods, as follows:

BREAD AND MILK.

This may well be the chief, if not the only, dish in the supper of little children. If the milk is not very rich, the bread should be spread with butter. Use well-baked bread, at least a day old, or toast, or occasionally crackers.

CEREALS AND MILK.

Thoroughly cooked cereals served once a day for the first course and once a day for dessert encourage the use of milk. Directions for preparing them will be found on page 15. Any cereal may be cooked in milk besides being served with it. Skim milk which might otherwise be thrown away may be used for the purpose. Rice, cooked in an uncovered double boiler, or in a pan in a very "slow" oven, can be made to absorb about six times its volume of skim milk. To cook a cupful of rice in this way instead of in water may be considered equivalent, so far as tissue-forming materials are concerned, to serving it with half a pound of lean beef.

MILK TOAST.

The following is a good method for making milk toast. Put on the table hot crisp toast or twice baked bread (see p. 15) and a pitcher of hot milk, slightly salted. One-fourth teaspoonful of salt to a cupful of milk is sufficient. Pour the milk over the toast as needed, using hot bowls or deep saucers for serving. This is the easiest way of serving milk toast, and, if care is taken to have all the dishes hot and to salt the milk, it is usually acceptable. A supply of twice-baked bread can be kept on hand and heated as needed to crisp it.

Another way to make milk toast is to thicken milk and pour it over toast. For 1 cup of milk allow $1\frac{1}{2}$ level teaspoons of flour and $\frac{1}{4}$ teaspoon of salt. Make a smooth paste out of the flour, salt, and a little of the milk. Heat the rest of the milk; add the flour and milk mixture and boil for about 5 minutes, stirring constantly, or cook 20 minutes in a double boiler, stirring constantly at first and frequently later on. If skim milk is used, a level teaspoonful of butter or bacon fat should be added after the gravy is prepared.

An easier and quicker method of making the sauce or "milk gravy" is to cook the flour thoroughly in a tablespoonful of fat before adding the milk. This, however, is not thought to be so wholesome as the kind of gravy in which the flour is cooked in the milk.

Milk gravy may be combined with dried beef or salt codfish which has been cut into small pieces and soaked in warm water, or with small pieces of tender meat, chicken, fish, or vegetables. Such gravy may be served with toast, with baked or boiled potatoes, or with boiled rice or other cereals. Dishes of this kind are more suitable for dinner than for supper.

Milk toast with the yolk of a hard-boiled egg grated over it makes an attractive dish. The whites of the hard-cooked eggs are not suitable for a young child nor for any child unless they are finely chopped or unless the child can be made to chew them well.

COCOA.

For variety, milk flavored with cocoa may be served. Prepared cocoa is the most convenient, but cracked cocoa shells or nibs, which require long boiling, may be used. A warm drink, made chiefly out of cocoa and water, is not to be confused with the more nourishing drink made by flavoring milk with cocoa, but it has its uses. Like clear soups, which contain little food in themselves, it may lead the child to eat freely of bread and other needed foods.

MILK SOUPS.

Another good way to serve milk to children is in soups. Milk-vegetable soups are made from cooked vegetables, chopped or strained, which in this form may be given to even the youngest children, and milk (whole or skim) slightly thickened. The vegetable may be asparagus, peas, beans of various kinds, celery, potatoes, turnips, carrots, spinach, kale, chard, beet roots or greens, parsnips, lettuce, cress, cauliflower, or almost any other.

GENERAL RECIPE FOR MILK-VEGETABLE SOUPS.

2 cupfuls of milk.
1 tablespoonful of flour.
1 tablespoonful of butter.
Salt.

3/4 of a cupful of a thoroughly cooked vegetable, finely chopped, mashed, or put through a sieve.

Thicken the milk with the flour as for milk gravy; add the other ingredients. If the soup is too thick, as it may be if the vegetable is starchy, thin it with milk or water. Milk tomato soup is not recommended for the youngest children. When it is served a little soda should be added to prevent the milk from curdling.

MILK STEW.

1 quart of milk.
1 cupful raw potatoes cut into small pieces.

2 tablespoonfuls of butter or bacon fat.
1 cupful of codfish cut into small pieces or just enough to flavor the stew.

Soak the fish in lukewarm water until it is soft and the salt removed. Cook the potatoes in water until tender, drain them, add the milk and codfish, and bring to the boiling point; add the butter, and salt to taste.

In place of the codfish any other salt or fresh fish, oysters, or a little chipped beef may be used. Or the fish may be omitted and the soup made savory and palatable by adding a few drops of onion juice, or a vegetable cut into small pieces and cooked thoroughly.

CEREAL-MILK PUDDINGS.

Puddings made with milk and bread, rice, or some other cereal food, have long been recognized as desirable in the child's diet.

Such milk puddings as old-fashioned rice or Indian pudding may be the means of serving much milk in a wholesome way. From the following recipe for rice pudding other recipes can be easily made, the proportions in all cases being about the same:

RICE PUDDING.

1 quart of milk.	½ teaspoonful of salt.
½ cupful of rice.	½ teaspoonful of ground nutmeg, or cinnamon, or the grated rind of ¼ of a lemon.
½ cupful of sugar.	

Wash the rice thoroughly, mix the ingredients, and bake three hours or more in a very slow oven, stirring occasionally at first.

GENERAL RECIPE FOR CEREAL-MILK PUDDINGS.

For a quart of milk allow one-third of a cupful of any coarse cereal (rice, corn meal, cracked wheat, oatmeal, or barley) and one-third of a cupful of brown, white, or maple sugar, sirup, honey, or molasses; one-half teaspoonful of salt; one-eighth teaspoonful of spice. The flavoring may be omitted when honey or molasses is used.

The above recipe makes quite a large pudding. It is often convenient to make a smaller one, and enough for a child's dinner can be made in the double boiler, allowing 2 level or 1 rounding table-spoonful each of cereal and of sugar (or other sweet) to a cupful of salted and flavored milk. Cook an hour or more without covering.

These puddings, if made thin, may be poured over stewed prunes or other cooked fruits, and are a good and economical substitute for the cream or soft custard usually used for that purpose.

CUSTARD AND OTHER MILK PUDDINGS.

There are many other milk dishes which are used in the same way as this milk and cereal pudding. Recipes for some of them follow:

Junket, or "rennet custard," is milk that has been coagulated or curdled, a process not unlike one of the first steps in digestion. The curdling is brought about by the addition of "junket tablets" to the milk. Milk containing rennet will, if not disturbed, "set" in one piece resembling a custard. Junket differs little from milk in food value except for the presence of the sugar used for flavoring, but it gives variety to the diet. If served very cold it is refreshing in warm weather.

JUNKET.

2 cupfuls of milk.	½ teaspoonful of salt.
½ cupful of sugar, honey, or sirup.	A few grains of nutmeg or cinnamon.
1 junket tablet.	

Warm the milk to about the temperature of the body, crush the tablet, and add it with the other ingredients to the milk. Pour into one large or several small dishes and place in a warm (not hot) place to harden. Cool before serving.

BOILED CUSTARD.

3 egg yolks.

2 cupfuls of milk.

 $\frac{1}{4}$ cupful of sugar, honey, or sirup. $\frac{1}{2}$ teaspoonful of salt.

Flavoring.

Heat the milk in a double boiler. Thoroughly mix the eggs and sugar and pour the milk over them. Return the mixture to the double boiler and heat it until it thickens, stirring constantly. Cool and flavor. If the custard curdles, remove it from the fire and beat with a Dover egg beater. This custard may be served in place of cream on many kinds of dessert.

FLOATING ISLAND.

In this dish the whites of eggs left over from boiled custard can be used to serve with it. Beat the whites until stiff; sweeten them a little; and cook them in a covered dish over water which is hot but not boiling; or cook them on top of the hot milk which is to be used in making custard. Lift them out with a wire egg beater or split spoon, and place on top of the custard. Decorate with small bits of jelly.

TAPIOCA CUSTARD.

Tapioca custards may be made as follows: Add to the list of ingredients for boiled custard one-fourth cupful of pearl tapioca. Soak the tapioca in water for an hour or two, drain it, and cook in the milk until it is transparent. Proceed as for boiled custard.

BAKED CUSTARD.

In making allow 1 egg and 2 level teaspoonfuls of sugar and a few grains of salt and of nutmeg for each cupful of milk. Beat the eggs slightly and add the other ingredients. Bake in cups set in a pan of water in a moderate oven.

SIMPLE ICE CREAMS.

In the way they are used, ice cream and frozen custard may be grouped with the puddings. Plain ice cream made out of thin cream, sweetened and flavored, or out of cream and custard mixed, may be given to children occasionally.

A good ice cream may be made as follows: Allow one-fourth cupful of sugar to each cupful of thin cream (half milk and half cream); flavor and freeze.

A frozen custard, commonly called by housekeepers "ice cream" or "French ice cream," which contains eggs as well as milk and cream, may be made as follows: For each half cupful of milk allow one-fourth cupful of sugar, one or two egg yolks or one whole egg, and a half cupful of cream. Make a custard out of all the ingredients but the cream. When it is cool, flavor it, add the cream, and freeze.

CARAMEL FLAVORING FOR USE IN CUSTARDS, ICE CREAMS, AND OTHER DESSERTS.

An economical flavoring for any of the above desserts may be made by browning or caramelizing ordinary sugar. To each cupful of sugar add one-fourth of a cupful of water. Heat until well browned, stirring constantly even after the dish has been taken from the fire, and until the danger of burning in the hot dish is passed. Before the mixture hardens, add hot water and cook until it is about the consistency of thick sirup. Bottle and save for use as needed.

MEAT, FISH, POULTRY, EGGS, AND MEAT SUBSTITUTES.

The other foods included in group 1 with milk (considered by far the most important of them all for children) are meat, fish, poultry, eggs, and meat substitutes.

In some families children do not get enough meat and eggs; in others they get too much. A good general rule commonly followed is to give a child 2 years old or over, an egg every other day and about the same amount (2 ounces) of meat, fish, or poultry on the days that come between. If for any reason meat is omitted from the child's diet special care must be taken to see that other suitable foods take its place—preferably an extra amount of milk or eggs.

Broiling and roasting are the best methods of preparing tender meat. Tough meat should be stewed or prepared in a fireless cooker, or first chopped and then broiled.

It is important to teach children to chew meat and other foods properly.

Fried meats, particularly those which are pan fried or cooked in a small amount of fat, should not be given to young children. One reason for this is that they are likely to be overcooked and tough, at least on the outside, and so are likely not to be properly chewed and to be swallowed in large pieces. Another reason is that the fat used in frying and also that which tries out of the meat is likely to be scorched and changed in composition. When this is the case, it is almost certain to be harmful.

Some recipes for cooking meat for children follow:

BROILED CHOPPED MEAT.

Many cuts of meat too tough to be broiled whole may be prepared very satisfactorily by being chopped, salted, and broiled. Allow about one-half teaspoonful of salt to a pound of meat. For very little children the meat should be scraped instead of being chopped, for in this way the connective tissue is taken out. An egg or a little milk may also be added. The most important point is careful handling, for if the meat is pressed together it becomes tough and hard. If a wire broiler is used, the cakes should not be squeezed between the two sides. To avoid this, lay them on top of the broiler and turn them with a knife and fork.

MEAT STEWS.

Stews made out of meat and vegetables offer a very great variety of dishes, good in themselves and good also because they encourage the eating of bread. The meat used should, of course, be in good condition but need not be from a tender cut. The lower-priced cuts may be used with good results, provided they are made tender by long, slow cooking. Any vegetable may be added, including the tougher parts of lettuce, and the leaves of celery. Rice, barley, macaroni, or even crusts of stale bread may be used in the stew to give variety. A stew containing a little meat, with one or more vegetables and a cereal, comes near to supplying all the needed foods, other than milk.

MEAT STEW.

2 pounds of one of the cheaper cuts of beef.	$\frac{1}{2}$ onion, chopped.
4 cups of potatoes cut into small pieces.	$\frac{1}{2}$ cup of flour.
$\frac{3}{4}$ cup each of turnips and carrots cut into $\frac{1}{4}$ -inch cubes.	Salt.

Cut the meat into small pieces, cover with boiling water, boil for five minutes, and then cook at a lower temperature until the meat is tender. This will require about three hours on the stove or five hours in the fireless cooker. Add the carrots, turnips, and onions, and salt during the last hour of cooking, and the potatoes 20 minutes before serving. Thicken with the flour diluted with cold water. If the dish is made in the fireless cooker, the mixture must be reheated when the vegetables are put in.

There is much to be said in favor of keeping a soup pot on the stove all the time, provided great care is taken not to allow the contents to grow stale. Into this pot can go clean portions of uncooked food and also clean foods left from the table, such as meat, milk, mashed potatoes, or other vegetables, crusts, cold cereal mushes, and even fruits. Soups made from such materials may not have great nutritive value, but, like those made out of materials bought for the purpose, they encourage the use of a large amount of bread, particularly if carefully seasoned.

POULTRY.

Chicken or turkey can be used for variety in a child's diet and are palatable stewed and served with rice. If roast chicken is used, select portions which are tender. It is well not to give a young child either highly seasoned stuffing (dressing) or rich gravy.

FISH.

The use of cured fish, fresh fish, and oysters in stews has been spoken of above. Boiled or stewed fish is also good for variety.

Eggs.

Eggs are especially useful food for young children. The chief point to remember in preparing them for children is that they must not be overcooked or they are likely to cause indigestion, as experience has shown. Everyone knows how the heat of cooking hardens the egg, and it is easy to understand why the digestive juices might have difficulty in penetrating such hard substance as the white of a hard-boiled egg. Overcooked yolks are also thought to be hard to digest. However, when eggs are cooked in the shell, the heat reaches the white before it does the yolk, and so there is more danger of the white being overcooked than of the yolk. The best ways of serving eggs for children are poached, soft-boiled, or coddled, though they may be scrambled for a change if one is careful not to scorch the fat used or to overcook the egg.

Coddled Eggs.

Many means have been suggested for cooking eggs in such a way that the yolks will be cooked and the whites will not be overcooked. One of the most satisfactory is by coddling and is done as follows: Allow a cupful of water to each egg, bring the water to the boiling point, remove it from the fire, put in the eggs, cover the dish closely, and leave the eggs in the water for about seven minutes. There is some uncertainty about this method, for eggs differ in weight and also in temperature at the time the cooking begins. On the whole, however, this method can be more depended on than others. Good results can be obtained by pouring hot water over eggs, if the same dish with the same amount of water is always used, but each cook must make her own rules.

MEAT SUBSTITUTES.

Milk and eggs, as stated above, are common meat substitutes. Among vegetable foods, dried beans, peas, lentils, and cowpeas, which are often classed together and called legumes, are the best substitutes for meat in the diet of older people, chiefly because they have large amounts of nitrogen needed for muscle building. In this respect they have some advantage, though not a great one, over cereals. Beans and the other legumes are not to be recommended for young children except when milk, meat, eggs, fish, and poultry are not to be obtained. When used they should be cooked until they are reduced to a mush. Since the skins are likely to be tough, it is well to put the cooked legumes through a sieve.

A general recipe for soups made from beans, peas, lentils, cowpeas, and other legumes follows:

SOUP FROM DRIED BEANS OR OTHER LEGUMES.

1 cup dried legumes.	2 tablespoonfuls of flour.
1 quart of water or soup stock.	Salt and other flavoring.
2 tablespoonfuls of butter or savory fat.	

Soak the dried legumes in water over night. Drain, add the water or stock, cook slowly on top of the stove for three hours or in a fireless cooker for four or five hours or until tender. Renew the water as it boils away. Strain and thicken with the fat and flour rubbed together. These soups may be flavored in many ways. Sometimes a tomato, onion, a few celery tops, a sprig of parsley, or a mixture of vegetables is boiled with the beans or peas, or just before serving a few drops of onion juice, a little celery salt, or one-half level teaspoonful of curry powder is added. Sometimes the water used is that in which ham or other meat has been boiled, but in such cases care must be taken not to have the liquid too fatty.

FOOD GROUP NO. 2.—BREAD AND OTHER CEREAL FOODS.

Cereal foods of some sort are used by children practically all over the world. Bread is the commonest cereal food in this country, though cereal mushes are also very generally used. Well-baked bread and thoroughly cooked breakfast cereals are both good for children and with milk should make up a large part of the diet. These two foods, bread and breakfast cereals, provide almost the same kinds of nourishment. Bread may therefore take the place, to a certain extent, of cereal mushes and cereal mushes may take the place of bread, but neither can take the place of milk, meat, eggs, fruits, and vegetables.

An ordinary slice of bread (a $\frac{3}{4}$ -inch slice cut from an ordinary loaf) is equal in food value to about half a cupful of boiled or steamed cereal and to about a cupful of puffed or flaked cereal. The mother who must feed her child very economically should calculate the cost of each and decide which is cheapest.

The relation of food to the condition of the bowels is an important matter. Grains, particularly those containing the outer or branny layers or coats, are laxative; so, too, are such mildly acid fruits as apples, oranges, and grapefruit. So far, therefore, as the important matter of preventing constipation is concerned, coarse grains and mildly acid fruits serve the same purpose. When fruits are to be obtained in abundance, the kind of cereal served is not of great importance. When they are not, the coarser cereals should be used. In the case of both cereals and fruits, it is possible to overdo. Sometimes the coarser parts, such as bran and skin, do not agree with the child and, under these circumstances, they should be removed from the food before it is served. Some mothers find it necessary to strain oatmeal porridge, for example, and to remove the skins of apples.

BREAD.

The yeast-raised bread given to young children should be at least a day old or should be toasted or twice baked. Most hot breads are

likely to be swallowed in large pieces and are therefore not desirable. Hot breads which are almost all crust, like thin tea biscuits or crisp rolls, are least likely to cause trouble.

MILK TOAST.

This very common bread dish has been discussed under milk. (See p. 7.)

TWICE-BAKED BREAD.

Bread cut or torn into small pieces and heated in a very slow oven until thoroughly dried and very delicately browned is good food for children. The warming oven of a coal stove is about hot enough for this purpose. In the case of gas ovens it is often difficult to get the gas low enough without having the door open a little way. The advantage of tearing instead of cutting the bread is that it makes it lighter in texture and easier to eat. The crust can be torn off from all but the ends of a loaf of bread in one piece. This crust should be torn into pieces about 2 inches wide. The inside of an ordinary loaf of bread will make 16 pieces of convenient size. Tear first across the loaf and then tear each half into eight pieces. It is usually necessary to make a small cut first in order to start the tearing. It is well to keep the crusts separate, as otherwise they are likely to get too brown. Such bread will need to be reheated before being served unless it is kept in a warm place, like a warming oven.

The above is also a good way to use stale bread. Some people crush it and use it with milk as a breakfast food.

BREAKFAST CEREALS.

Cereal mushes and other breakfast cereals are very common foods. Almost all of the well-known grains are used for this purpose, and there are many such products, owing to differences in manufacture.

Except when used for dessert, cereal mushes and ready-to-eat cereals should be served with milk and with very little, if any, sugar. If the cereals are heavily sweetened, children are likely to eat so much that they neglect other and much-needed foods. If carefully salted, mushes are more likely to satisfy the taste without sugar than otherwise. Well-cooked cereals with milk or stewed fruit or a little molasses, sirup, honey, or sugar make good desserts for dinner, lunch, or supper. If preferred, dried fruits, like dates and raisins, may be cooked with the cereal to sweeten it and to give flavor.

COOKING CEREAL BREAKFAST FOODS.

It is hard to give general rules for cooking cereals, for there are so many kinds, but it is safe to say that there is no danger of overcooking and much danger of undercooking them. Some grains need longer cooking than others—corn meal, for example, needs at least

three hours and rice hardly more than half an hour. In general, whole grains, like whole wheat, or grains more or less finely broken, like cracked wheat, require longer cooking (three hours at least) than more finely-ground grains, such as farina (which should be cooked one hour at least). Breakfast foods made from grains with the outer coverings left on require more cooking than those with the outer covering removed—whole barley, for example, more than pearl barley. Many cereal foods, particularly the rolled and flaked types, have been partially cooked at the factory. These require less cooking in the home than those which have had no such treatment; but if they are to be served to children such cereals should be cooked at home for at least an hour. There are also cereal breakfast foods which have been still more thoroughly cooked at the factory, either by parching in addition to flaking or by some other special method. These are improved by putting them into the oven long enough at least to crisp them.

Oatmeal, corn meal, and many other granular cereals can be put directly into cold water and cooked satisfactorily in a double boiler without stirring, the method being particularly good in the case of corn meal, which is likely to be lumpy if stirred into hot water. A convenient method for cooking cereals is to mix with the usual quantity of water, bring to the boiling point, boil for three or four minutes, and then put into a fireless cooker and leave 10 or 12 hours. Porridge or mush made in this way must be reheated before serving.

The quantity of water required differs with the cereal. A cupful of rolled oats requires at least 2 cupfuls of water; oatmeal or corn meal, 4 cupfuls; and rice, 3 cupfuls.

A level teaspoonful of salt to a cupful of cereal will usually be right, but it is well to experiment a little with an unfamiliar cereal, since failure to salt mushes properly very often leads children to dislike them.

FOOD GROUP NO. 3.—BUTTER, CREAM, TABLE OIL, AND OTHER FATTY FOODS.

Fat is an important part of the food of children. This is not surprising, for it is found in considerable amounts in human milk, the natural food for babies. Butter, which consists chiefly of separated milk fat, and cream, which is rich in milk fat and also in the other nourishing substances of milk, are both wholesome. Salad oils of various kinds (olive, cottonseed, peanut, and others) may be given to children in small amounts. Those who are not used to table oil must often be trained to like it. This can usually be done by introducing it very gradually into the diet. A good way to serve it is on spinach and other greens or on tender salad vegetables.

There is more than an ounce of fat (at least $2\frac{1}{2}$ level tablespoonfuls) in a quart of whole milk. If the healthy child is given a quart of milk, has butter on its bread, and meat or an egg once a day, he gets enough fat and that which he receives is in wholesome form. It is well, therefore, not to give such fatty foods as pastry, fried meats and vegetables, and doughnuts or rich cakes, for in these the fats are not in so good a form for children, as experience has shown. If the child is constipated, the occasional use of cream or salad oil is desirable, for fat in abundance is laxative.

Bacon or salt pork, cut very thin and carefully cooked, may be given occasionally, but thick pieces with much lean are not desirable. In preparing bacon or salt pork it is very important not to burn the fat. To avoid this they should be cooked in one of the following ways: Put the slices on a broiler or wire frame over a pan; place the pan into a hot oven and cook long enough to remove most of the fat. Or keep a pan on purpose for cooking bacon on top of a stove and let the fat which fries out of it collect in the pan, taking care that none is burned. In time so much fat will collect that bacon can be dropped into this hot fat and will be less likely to burn than if placed on a hot pan.

FOOD GROUP NO. 4.—VEGETABLES AND FRUITS.

Two very valuable kinds of food are here grouped together, namely, vegetables and fruits. This is done because they are similar in that both kinds supply iron, lime, and other mineral matter to the body, and also mild acids (not always in such amounts that one can taste them), such as those which are found in oranges, apples, and tomatoes.

Vegetables are an important but often a neglected part of a child's diet. They should be served at least once a day, as they help to keep the bowels in good condition. Several of the ways of accustoming the child to the taste of unfamiliar vegetables have already been suggested here. They may be used as flavoring for soups and stews, may be added to milk or meat stews, or served with meat gravy. If gravy is used, it should not be too fat nor made with scorched fat.

Young children may be given the young and tender parts of celery and lettuce, a satisfactory way of serving being in the form of sandwiches. For this purpose they should be slightly salted and the celery should be chopped or cut into small pieces.

All vegetables, whether served raw or cooked, should be washed with great care. Large vegetables like potatoes and carrots should be scrubbed with a brush. Greens should be washed leaf by leaf under running water, or in a large amount of water. In the latter any sand which clings to them is likely to sink. To prevent it from

again getting on the vegetables lift them from the water instead of pouring the water off.

Most vegetables when served as a separate dish should be either steamed, boiled, baked, or stewed. If the supply of fresh vegetables is not generous, the juice in which they are cooked should be used with them as far as possible, or put into soups or stews.

Experience has shown that vegetables, particularly green vegetables, are at their best when cooked until tender, but not until completely wilted. Spinach requires cooking from 20 to 30 minutes.

Vegetables should be served either quite simply or with a little milk, cream, or butter, to improve or vary the flavor. As said before, oil may be served on greens instead of butter. These simple methods are better than complicated ones like frying or scalloping. For the smallest children such vegetables as greens should be finely chopped, and if the tougher portions of other vegetables, the skins of green peas, for example, are found to disagree with a child, these portions should be removed by putting the cooked vegetable through a sieve. No such vegetables as raw radishes or cucumbers, which might easily be swallowed in large pieces, should be given to small children.

Fruits, which with vegetables make up group 4, are also very important in the child's diet. They supply mild acids, and they are important for their flavor, for their laxative effects, and no doubt for other reasons also. This laxative effect is well recognized in the very general use of orange juice, prunes, and apples. Then, too, the fruits, like the vegetables, have mineral elements which the body requires.

Fruits should be served in some form at least once a day. In general, the same rule should be followed as for vegetables in deciding in what form they should be served. Fruit juices and the pulp of cooked fruit, baked apples and pears, and stewed prunes, for example, are safest. Whether the skins should be given depends partly on the age and health of the child and partly on the way the fruit is prepared. If the skins are very tender, they are not likely to cause trouble, except with very young children. When apples and pears are baked the skins can be made tender by frequent basting.

FOOD GROUP NO. 5.—SIMPLE SWEETS.

Simple sweets are such things as lump sugar, maple sugar, sirups, honey, and plain candy, and those foods in which sugar is combined in simple forms with fruit juices (in lemonade, water ice, jelly, etc.), with flour or starch, as in plain cakes (cup cake, sponge cake, cookies), and with fruit, as in jams, marmalades, and similar things. Sweets which contain much fat, like rich cakes and pastry, and foods which are made rich with nuts or dried or candied fruits, or those which are highly flavored or spiced, can not be classed as simple sweets.

Sugar is a desirable part of the diet, and the only objection which can be raised to its use in reasonable amounts in a mixed diet is that it is sometimes allowed to take the place of foods which come under the first four groups mentioned in this bulletin, and so spoils the child's appetite for those other important things. Under these conditions it is harmful, because its improper use has led to bad food habits. Sweets should not be given between meals or during the first course of a meal. Careful mothers who forbid their children eating candy at odd times sometimes give one or two pieces of wholesome candy as a "treat" with dessert at dinner.

A REVIEW.

In the foregoing pages some general principles which should govern the young child's diet have been stated and facts given about foods the child should have and about cooking them.

At the close of the day the mother might ask herself questions like the following to make sure that she has taken into account the things to which her attention has been directed:

Did each child take about a quart of milk in one form or another?
Have I taken pains to see that the milk that comes to my house has been handled in a clean way?

If I was obliged to serve skim milk for the sake of cleanness or economy, did I supply a little extra fat in some other way?

Were the fats which I gave the child of the wholesome kind found in milk, cream, butter, and salad oils, or of the unwholesome kind found in doughnuts and other fried foods?

Did I make good use of all skim milk by using it in the preparation of cereal mushes, puddings, or otherwise?

Were all cereal foods thoroughly cooked?

Was the bread soggy? If so, was it because the loaves were too large, or because they were not cooked long enough?

Did I take pains to get a variety of foods from the cereal group by serving a cereal mush once during the day?

Did I keep in mind that while cereals are good foods in themselves, they do not take the place of meat, milk, eggs, fruit, and vegetables?

Did I keep in mind that children who do not have plenty of fruit and vegetables need whole-wheat bread and whole grains served in other ways?

Did each child have an egg or an equivalent amount of meat, fish, or poultry?

Did any child have more than this of flesh foods or eggs? If so, might the money not have been better spent for fruits or vegetables?

If I was unable to get milk, meat, fish, poultry, or eggs, did I serve dried beans, or other legumes thoroughly cooked and carefully seasoned?

Were vegetables and fruits both on the child's bill of fare once during the day? If not, was it because we have not taken pains to raise them in our home garden?

Did either the fruit or the vegetable disagree with the child? If so, ought I to have cooked it more thoroughly, chopped it more finely, or have removed the skins or seeds?

Was the child given sweets between meals, or anything that tempted him to eat when he was not hungry?

Was he allowed to eat sweets when he should have been drinking milk or eating cereals, meat, eggs, fruit, or vegetables?

Were the sweets given to the child simple, i. e., unmixed with much fat or with hard substances difficult to chew, and not highly flavored?

Was the child made to eat slowly and chew his food properly?

A young child may be considered well fed if he has plenty of milk, bread, and other cereal food; an egg once a day or its equivalent in flesh foods; a small portion each of carefully prepared fruits and vegetables, with a small amount of sweet food after his appetite for other foods is satisfied. If there is too much or too little of any of these, his diet is one sided.

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UNITED STATES DEPARTMENT OF AGRICULTURE



FARMERS' BULLETIN



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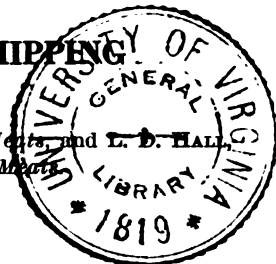
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APRIL 10, 1916

Contribution from the Office of Markets and Rural Organization, Charles J. Brand, Chief.

COOPERATIVE LIVE STOCK SHIPPING ASSOCIATIONS.

By S. W. DOTY, *Assistant in Marketing Live Stock and Meats*, and L. D. HALL, *Specialist in Marketing Live Stock and Meats*.



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INTRODUCTION.

In sections where live stock production is incidental to other systems of farming, and more especially in dairying districts where most farmers have only a small number of animals to sell at one time, there is a considerable amount of stock in excess of local demands which must be marketed by farmers in less than carload lots. Even in sections where stock feeding predominates a similar condition exists. The low grade of these small lots of stock, particularly of cattle, ordinarily causes them to be discriminated against unjustly, and when abnormal market conditions and fluctuations occur local buyers and shippers are compelled to purchase at large margins under market prices in order to be certain of their profit.

On account of limited local demand, a large part of the live stock of the country must be shipped to the central markets. This fact has

NOTE.—This bulletin is intended to give to farmers and stockmen who have small numbers of live stock to sell information as to how to organize for the purpose of making car-lot shipments to central markets. It should be of special interest to communities which do not have satisfactory local markets for live stock, and where cooperative shipping associations are feasible.

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made it possible for local buyers to operate extensively in farming sections, where the individual farmer does not produce in numbers sufficient to ship in carload quantities. The margin of profit on which these country buyers operate is often exorbitant. In some communities the buyers, contrary to law, are said to have an understanding among themselves whereby they eliminate competition and force the farmers to sell at fixed prices. To a large degree these factors account for the rapid spread of the cooperative shipping movement.

ORIGIN AND EXTENT OF THE MOVEMENT.

Farmers' live stock shipping associations are one of the newer forms of organized cooperation. Although for many years it has been more or less common for several farmers in a community to combine their live stock to make a carload for shipment to market, it is only within the past seven years that associations have been formed for this purpose. The first cooperative organization for shipping stock in this country of which any record has been found was formed at Litchfield, Minn., in 1908. The immediate success of the enterprise prompted similar organizations in other communities, until at the present time the Department of Agriculture has a list of approximately 500 organizations in the various States that are shipping stock in a cooperative way. About 200 of these are in Minnesota, and the remainder are divided among the following States in numerical order: Wisconsin, Nebraska, Iowa, North Dakota, South Dakota, Kansas, Michigan, Illinois, Indiana, and Ohio. Included in this total are a number of cooperative elevators and other farmers' organizations that are conducting a live stock shipping business as a branch or department of the organization.

ADVANTAGES OF SHIPPING ASSOCIATIONS.

Several advantages are derived by farmers from cooperation in marketing their stock. Foremost among them is the greater net return to the farmer. He receives the actual market price for his stock, less the cost of marketing. Returns from thin stock, calves and lambs shipped in this way often are surprising, as it is on these classes of stock that the local buyers ordinarily make their largest profits, 100 per cent being not uncommon.

The economy in time and labor spent in collecting and delivering stock for shipment is an important feature of the shipping association. Usually there are several buyers operating in a community, driving about from farm to farm dickering with the farmers for their stock. Wherever the farmers have organized shipping associations the business of local buyers has been reduced and in some cases entirely displaced. One association manager often is enabled to ship

the stock from the same territory formerly covered by several local shippers. It is reported from one county of Minnesota in which shipping associations have been organized that seven association managers now are shipping the stock previously purchased by 24 local stock buyers. A similar condition exists in numerous other localities.

Through these associations the farmer usually can market his stock when it is ready and does not have to wait until a local shipper is ready to buy it. Further, he is reimbursed for animals killed or injured in transit, whether he consigns one head or a carload of stock. This is made possible by a fund set aside for that purpose, concerning which mention will be made later. Another advantage of importance is the consideration received at the central market, due to the volume of business handled through the association.

HOW TO ORGANIZE.

The simple form of organization that suffices for such associations is one of their leading features. In the first place, practically no capital is required, since payment is not made to members for stock shipped until the returns are received from the market. To organize it is necessary only that the farmers of a community meet together, adopt a simple constitution and by-laws, and elect officers and a board of directors, who in turn appoint a manager.

Although in order to transact business it is not necessary for an association of this nature to incorporate under the State laws, it is advisable to do so as a protection to the members. If not incorporated the organization, as such, can not sue or be sued, and in case of the loss of stock from railroad wrecks or other cause the manager could not enforce claims for the association, but each shipper would be compelled to present claims for his own losses. The cost of incorporating is comparatively small—usually not more than \$10.

The following form of constitution and by-laws for farmers' co-operative live stock shipping associations originated with the association at Litchfield, Minn., and is one which is being used by many associations in Minnesota and other States.

CONSTITUTION.

ARTICLE I.

Name.—The name of this organization shall be —.

ARTICLE II.

Place.—The place of operation shall be in — and vicinity, and all regular and special meetings shall be held in —, as prescribed in the by-laws.

ARTICLE III.

Time.—The time over which this organization shall extend shall be indefinite.

ARTICLE IV.

Purpose.—The purpose of this organization shall be to obtain reasonable prices and to secure the best possible results in the marketing of live stock.

ARTICLE V.

Membership.—Any person making use of the shipping facilities of this association shall be entitled to membership by paying a membership fee of —.

ARTICLE VI.

Management.—This organization shall be managed by a board of directors, composed of — members of the association, who shall be elected at the annual meeting. In case of vacancy, caused by resignation or otherwise, in the membership of the board, the same shall be filled by the remaining members of the board, and the member so elected shall hold office for the unexpired term, or until new members are elected and qualified. The board of directors shall appoint a manager, who shall not be one of their members. They shall decide on the system of accounting to be used, and shall provide for suitable auditing of the manager's accounts.

ARTICLE VII.

Officers.—Immediately after the annual meeting the board of directors shall elect from their own members a president, a vice president, and a secretary-treasurer. These officers shall hold the same office in the association as in the board. All officers shall hold office one year or until their successors have been elected and qualified.

ARTICLE VIII.

Amendments.—Amendments to this constitution may be made at any regular meeting by a two-thirds vote, when 30 days' notice of the same has been given by announcement to the members.

ARTICLE IX.

Quorum.—A majority of members of the board shall constitute a quorum and may do any business that may properly come before said board.

ARTICLE X.

By-laws.—By-laws and rules covering the operation of this association may be made from time to time in the manner prescribed for the amendments to this constitution.

BY-LAWS.

CHAPTER 1.

The shipment of stock in this association shall be made regardless of membership, and the delivery of stock to the manager and the acceptance thereof by him binds the shipper to the rules and by-laws of this association. All who

desire to ship stock with the association shall report to the manager the kind of stock, the number of each kind, and the approximate weight of each, when it is ready to be marketed. When a sufficient amount of live stock has been reported to be ready for shipment to make a full carload, the manager shall order a car for making the shipment, and shall notify each party having stock listed, and state at what time the stock is to be delivered for loading.

CHAPTER 2.

SECTION 1. Duties of the manager.—The manager shall be at the yard on the day the shipment is to be made, unless he shall have secured a competent substitute, and shall receive all the stock, and weigh, mark, and load the same on the car. He shall have charge of and direct the sale of all shipments, and receive all money therefor, and pay the same to the shippers, less his commission and all other expenses incurred in making the shipment, or when so directed send the money by mail to the shippers. He shall furnish a statement to every shipper, showing net weights, prices received, and expenses of shipment. He shall keep on file a complete statement of settlement, together with returns from the commission firm selling the live stock for the association. In a book kept for that purpose, he shall keep a record showing the number of cars shipped, and the amount of stock in such cars, during the year. He shall also keep an account of all disbursements and receipts for the association. At the annual meeting he shall furnish a detailed statement of all business done during the year.

SECTION 2. The manager shall receive as compensation for his services the amount of — cents per hundred pounds of stock sold by him, and no other compensation from the association, except that he shall have the right to charge for any outlay for materials needed in making partitions to separate the stock in the car and for bedding, said amount to be charged to the expense of the shipment for which it was incurred.

SECTION 3. The manager shall furnish a satisfactory bond, which shall be approved by the board of directors. Said bond shall be for the faithful discharge of his duties.

CHAPTER 3.

SECTION 1. Protection fund.—There shall be deducted on every hundred pounds of weight of sheep and hogs 3 cents, and for every hundred pounds of live weight of cattle 2 cents, and the same shall be placed in the sinking fund, to be used for the paying of losses that may occur to any stock from the time it comes into the hands of the manager until final disposition of same is made.

SECTION 2. Losses—How paid.—Any shipper whose stock has been damaged by injury while in the hands of the manager shall receive the full amount for the same as though the stock had not been injured, but shall be subject to the same ratio of expense on the shipment. The payment of the damage shall be based on a statement made by the commission firm having charge of the shipment, which statement shall show the amount received for the injured animal and the amount, in their opinion, it would have brought had it not been injured. This statement shall be the final basis for settlement. No damage shall be paid for an animal which was not in healthy condition when received at the local yards by the manager.

CHAPTER 4.

SECTION 1. Unhealthy stock.—All stock which must be sold subject to inspection, except such as has been injured while in a healthy condition and in charge

of the manager, or any diseased animal, shall be received at the owner's risk and he shall receive such payment therefor as is received by the commission firm, less all expenses figured pro rata on the shipment.

Several years' experience with the foregoing constitution and by-laws has brought forth the following suggestions from association managers in the way of changes and additions:

Article VI of the constitution states that the board of directors shall be elected at the annual meeting. It is recommended by officials of some of the more successful associations that instead of electing the full board at one time a portion of the members be elected each year, so that at all times the board will be composed of members a majority of whom have held office for at least one year and are therefore familiar with the details of the business.

In addition, Article VI should specify the time of holding the annual meeting. It is suggested that this be held during the early winter, preferably not later than the first week in January. This is generally the heaviest shipping period, and the members are therefore particularly interested in the business of the association. It is also the time of year when the farmers can attend most conveniently.

Wherever agreeable to members it is considered advisable that the office of secretary and treasurer be held by a banker or other business man in the town in which the organization operates instead of by a farmer located several miles out of town. Bankers usually are somewhat familiar with the live stock business and are conveniently situated and equipped to perform the duties of the office.

Some associations recommend that a clause be included in the by-laws to provide for the assessment of damages in case of the non-delivery of stock that has been listed for shipment on a certain day. This is one of the common difficulties experienced by live stock shipping associations. The manager orders car space for a certain amount of stock and when a part of this stock is not delivered the shipping expenses of the other members are increased proportionately. It is thought, therefore, that by requiring negligent members to pay the loss sustained through nondelivery of stock the trouble would be brought to a minimum.

The managers of some of the older associations, together with others familiar with the details of the business, advise that the sinking fund be limited to an amount sufficient only for emergencies. The board of directors should determine the size of the fund, and when the full amount has been accumulated the charges should be so fixed as to maintain it at about that point. This would do away with the possibility of any trouble arising from the distribution of a surplus as dividends among the members. Therefore it is suggested that chapter 3, section 1, of the by-laws be amended to this effect.

In order that the shipments of the association may be disposed of in whatever manner may be found most advantageous under varying conditions, the following may be added to the fourth sentence of section 1, chapter 2, of the by-laws: *or from the purchaser of the stock.* Similarly, section 2 of chapter 3 may be modified by inserting after "shipment" *or by the purchaser of the stock.*

Some associations have included in the by-laws a chapter stating that nonmembers who ship stock with the association will be charged a small fee for the privilege. This fee varies from 2 to 5 cents per hundredweight and is placed in the general fund. The advisability of such a plan, at least until the association is well established in a community, is doubtful. Many are of the opinion that it tends to keep farmers from shipping their stock with the association, and as successful cooperation depends largely upon patronage every effort should be made to assure it. Moreover, if the association wishes to do an interstate business, it is very desirable that it should have the benefit of the exemption conferred by section 6 of the Clayton Act¹ upon agricultural organizations.

If the association deals with the nonmember, in order to comply with the requirements of section 6 it is necessary for it to deal with him upon the same terms as it does with a member. Any charge to a nonmember patron in excess of the cost of the service rendered him and his proportionate share of the expense of operating the association would strip the organization of its nonprofit character, and thereby deprive it of the privileges which strictly cooperative organizations enjoy under the United States antitrust laws.

On account of the wide variation in local conditions it is not feasible to formulate a uniform constitution and by-laws for associations in all sections. Therefore it will be advisable in many cases to consider such minor modifications of the foregoing forms as may adapt them to the conditions of the community in question. Competent legal counsel should be consulted concerning the articles of organization, to insure that they conform in every particular to the statutes of the State and the United States antitrust laws, if conducting interstate business, and provide the utmost protection to members of the association.

¹ Section 6 of the Clayton Act is here set out in full for the guidance of those who may desire to shape their organization in conformity with its requirements.

Thirty-eighth United States Statutes at Large, page 731.

"That the labor of a human-being is not a commodity or article of commerce. Nothing contained in the antitrust laws shall be construed to forbid the existence and operation of labor, agricultural, or horticultural organizations, instituted for the purposes of mutual help, and not having capital stock or conducted for profit, or to forbid or restrain individual members of such organizations from lawfully carrying out the legitimate objects thereof; nor shall such organizations, or the members thereof, be held or construed to be illegal combinations or conspiracies in restraint of trade, under the antitrust laws."

THE MANAGER: QUALIFICATIONS AND DUTIES.

Special care should be given to the selection of the manager, as the success of the association largely rests with him. It is essential that he be both honest and capable, with a thorough knowledge of live stock and an understanding of business methods and principles. Some associations have employed local stock buyers as managers. These buyers as a rule thoroughly understand the shipping and marketing of live stock and are well acquainted with the farmers of the community. Such men are exceptionally well fitted to manage a shipping association if they are able to grasp the spirit of cooperation and have the confidence of the farmers.

The duties of the manager are as described in the foregoing by-laws. He must see that proper car space is ordered to contain the stock listed for each shipment and be on hand on shipping days to receive, mark, and weigh the stock and see that it is properly loaded. He must determine the market and commission firm to which the stock is to be consigned, and, whenever possible, accompany the stock to market to see that it receives careful attention and to keep posted on market prices and conditions.

MARKING, SHIPPING, AND SELLING.

Usually a certain day of the week is set aside for the shipment of stock to market. This may be determined by the board of directors or by the association at a general meeting. In so doing, consideration should be given to the market to which the stock is to be consigned, in order that it may arrive there at the most advantageous time. The shipping date being fixed, the farmers notify the manager by telephone or otherwise of the number of head and approximate weights of the different kinds of stock they have to ship. This should be done several days in advance so that the manager will have sufficient time to arrange for cars. In case there is not sufficient stock to fill a car on the appointed day, shipment may be deferred until enough has been reported, in which case the manager notifies the farmers who have stock listed as to the day he will receive it. (See fig. 1.)

It is important that stock listed for shipment on a certain day be delivered unless a release is procured from the manager. This avoids inconvenience both to the manager and to the other members. As previously stated, in some associations a fixed amount is exacted from a shipper for failure to deliver stock to the manager as agreed. In every case the amount to be exacted should be reasonable and should fairly represent the actual loss which it is estimated the association will suffer as a result of nondelivery. The provision for liquidated damage is proper because the manager must arrange for a certain amount of car space, and freight must be paid on minimum carload weights.

On the regular shipping days the farmers deliver their stock to the manager, who weighs and marks it. He also issues a receipt for each delivery showing the name of the farmer and the number, class, weight, and mark of the stock. A manifest, that is, a record of all deliveries in the shipment, is then made and summarized on a card or sheet prepared for that purpose. This prevents duplication of marks and furnishes a record for the commission firm to which the stock is consigned. In case the manager does not accompany the stock to market, this record may be tacked in the car, and when the stock is unloaded at the yards the card is removed by a yard em-



FIG. 1.—Shipping day at Litchfield, Mich. Association members delivering stock.

ployee and delivered by him to the commission firm. In some cases where sufficient time elapses this record may be mailed by special delivery letter to the commission firm.

To facilitate identification of stock, each shipper is given a number or character for each class of animals, and his stock is marked accordingly. Marking usually is done in one of the following ways:

(1) By clipping Roman numerals or other characters with scissors on some conspicuous part of the animal. A pair of 8-inch scissors with curved blades, costing about 50 cents, has been found very satisfactory for this purpose. Some managers prefer small straight scissors similar to those used by barbers.

(2) By the use of paint. Ordinary paint has been found unsatisfactory for marking hogs, as it does not dry readily enough to pre-

vent smearing. For this purpose the paint should contain about 25 per cent varnish.

(3) By the use of numbered ear tags. This method is used the least of the three. Often it is difficult at the stockyards to get close enough to the animals to see the number on the tag. For that reason tags are considered objectionable by many associations.

The common method of marking cattle and calves is to clip the mark on the right hip of the animal. (See fig. 2.) To designate a fresh cow and calf in a shipment the same numeral is clipped on the right shoulder of each animal. Some associations number the animals consecutively instead of indicating the stock of each shipper by a certain mark or numeral. This is particularly desirable in case of cattle that are pooled at the market. Also, the position of

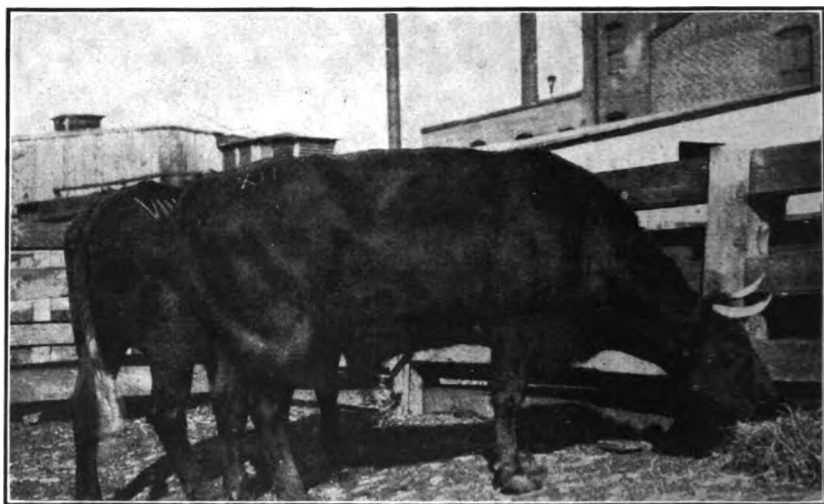


FIG. 2.—A satisfactory method of marking cattle for shipment. Numerals clipped in hair with scissors.

the mark on the animal may designate the owner. Thus the same number may be used on the right hip to denote one owner, on the left hip to denote another owner, on the sides, shoulders, or neck for other owners. In this way many animals can be marked without using large numerals in any case. The important features of any system of marking are that it should be uniform for all shipments, and the marks should be plain and on a conspicuous part of the animal.

Sheep usually are marked with paint applied to the top of the head, the shoulders, back, or hips. By using several combinations and different colors a large number of sheep may be marked. Branding fluid is preferable to paint for marking sheep, as it does not

injure the wool. Paint will not scour out and therefore is objectionable from the standpoint of wool manufacturers.

Hogs may be marked by any one of the three methods mentioned above. Paint generally is used because it is most convenient to apply and the marks are most easily distinguished. A round brush 1 inch in diameter may be used and stripes made across the back. By using different colors of paint and varying the number of stripes and their position on the animals, a large number of lots may be given different marks that are easily distinguished. Some associations are marking hogs very successfully by clipping marks on the backs of the animals. It is a simple matter to mark hogs if done before unloading from the wagon.

In many associations hogs are not marked, but those of each shipper are graded by the manager at the shipping point, and a record of sows, boars, and stags subject to dockage is kept. In this case the hogs are pooled at the market and shrinkage is prorated on the basis of weight. However, as a matter of protection to the owners, the marking of hogs is strongly advocated, because in case hogs of a certain mark show that they have been "stuffed" before delivery, or that they have shrunk excessively, or in case of discrepancy in dockage, the proper adjustments can be made. Hogs of the same grade, though marked differently, usually are sold together at the market and the shrinkage prorated as in the case of unmarked shipments.

It is an advantage to shippers to have all hogs of the same grade in a shipment weighed together at the market, thereby avoiding a large number of drafts on the scales and the loss due to the fact that the stockyard weights show only 10-pound points. The same is true of sheep and calves. In the case of cattle, however, the shrinkage may differ considerably among the different animals in a shipment. It is desirable, therefore, that the cattle of each owner be weighed separately at the market in order that each may stand his proper share of the total shrinkage.

FEEES.

An annual membership fee is required from each person who ships stock through the associations, excepting in some instances where an additional shipping charge is made to nonmembers. The fee is small, usually not more than 50 cents, and is deducted annually from the returns of the first shipment of each farmer. A specified rate per hundredweight or car also is deducted from each shipment to cover the manager's commission and running expenses and to provide for a sinking fund.

The amount set aside for the manager's commission varies among the different associations from 5 to 8 cents per hundredweight. Some

associations, instead of basing the manager's compensation on live weight, pay him a specified amount per car, usually \$10 to \$15 for the first car and \$5 for each additional car of a shipment.

The sinking or protection fund is in the nature of an insurance and is set aside for the purpose of paying for animals killed or injured in transit. The usual amounts deducted for this fund are 2 cents per hundredweight on cattle and 3 cents per hundredweight on hogs, sheep, and calves. This is the most common method and usually the most satisfactory. At least one association, instead of computing the sinking fund on the basis of weight, deducts 2 per cent of the proceeds of the shipment to provide for this fund and all home expenses. The advantage claimed is that each shipper bears expenses in proportion to the value of his stock. However, the labor and other expense required to market a poor animal is as great as in the case of a good animal. Other things being equal, therefore, it seems more equitable to base expenses on weight than on value.

As previously stated, a considerable amount of live stock shipping is done by farmers' cooperative elevator companies. Generally they buy the stock outright, just as they do grain, and return the profits as dividends to the stockholders. In some cases, however, the live stock shipments are handled on the same basis as in a separate live stock shipping association.

PRORATING THE PROCEEDS.

After the shipment is sold an account sales is rendered by the commission firm to the manager of the association, and a check for the proceeds of the sale, less freight and market expenses, is remitted.

Figure 3 presents an actual account sales of a carload of mixed stock. It shows the use of different marks in accounting for each owner's animals, thereby enabling the manager to prorate the various items.

Upon receipt of the account sales and remittance, the manager prorates the shrinkage, expenses, and proceeds among the various owners of the shipment. An itemized statement is made by the manager or secretary for each owner, showing home and market weights, price per pound, and amount received for his stock, his share of home and market expenses, and his net returns. This statement accompanies the check sent to each owner.

It is advisable to designate each shipment by a number and to insert the shipment number on each farmer's check as it is sent out. This serves as a safeguard against error and simplifies the manager's records. The books should be carefully audited by the board of directors and be open for inspection by any member at all times. Absolute publicity of accounts should be provided.

A preliminary study of the office methods of these associations indicates that a systematic and simple accounting system is a universal need; accordingly a plan of this kind has been devised by the specialists in marketing business practice in the Office of Markets and Rural Organization. The system is now being used by five associations

(NAME OF COMMISSION FIRM)

(Marked)

(Date)

Sold for account of (Name of Shipping Association)

No. _____ Shipping Point _____ Post Office _____

[illegible]

FIG. 3.—Account sales of a carload of mixed stock.

in different States, and as soon as perfected to the proper point it will be prepared for distribution among associations desiring to introduce it.

PRACTICAL RESULTS.

The yearly increase in the number of cars of stock shipped by various live stock shipping associations is evidence of the fact that farmers are quick to see the benefits derived from cooperation in the shipping of stock.

The following figures show the yearly increase in business of three associations and may be considered indicative of what is being accomplished by some of the more successful associations in other States.

Litchfield (Minn.) Farmers' Shipping Association.

Year.	Carloads of stock.	Gross receipts.
1908-----	14 -----	\$11, 599. 26
1909-----	35 -----	39, 669. 27
1910-----	81 -----	102, 163. 37
1911-----	104 -----	114, 764. 56
1912-----	146 -----	181, 544. 10
1913-----	153 -----	218, 116. 25
1914-----	173 -----	256, 044. 14

St. Charles (Minn.) Inter-County Farmers' Shipping Association.

1911-----	65 -----	-----
1912-----	97 -----	104, 576. 00
1913-----	109 -----	135, 383. 77
1914-----	169 -----	216, 017. 24

Atwater (Minn.) Live Stock Shippers' Association.

1911-----	29 -----	26, 606. 00
1912-----	62 -----	68, 164. 00
1913-----	75 -----	102, 425. 92
1914-----	89 -----	124, 228. 40

From these records it is seen that the first seven years' business of the Litchfield, Minn., association amounted to a total of 706 cars of stock (or 14,797,054 pounds using the average weight per car for 1913 and 1914). The average cost of marketing stock in this association for 1913 and 1914 was 33 cents per 100 pounds. This latter figure is said by farmers to be from 10 to 40 cents per hundredweight below the margin on which local buyers formerly purchased stock from farmers. Assuming the local buyer's margin to be 50 cents per hundredweight, a very conservative estimate, the association at Litchfield, Minn., saved the shippers \$6,221.15 during the year 1914, and has saved them a grand total of \$25,155 since its organization. Considering the fact that there are about 200 of these associations in Minnesota, enormous benefit to the farmers is obvious. It has been estimated that in 1914 approximately \$6,000,000 worth of live stock was shipped by cooperative associations in Minnesota. Officials familiar with conditions in the State believe that within a few years a large percentage of the stock sent to central markets from Minnesota will be marketed in this way.

As further evidence of results obtained, the following is quoted from a "Report upon Cooperation and Marketing," published by the Wisconsin State Board of Public Affairs in 1912:

One farmer writes—

"Veal, for instance, which brought \$5 per hundred before, brings \$7.25 per hundred now that we do our own shipping. Butchers often offered us one-third of what calves were worth and called us crazy when we complained. We are now shipping together every two or three weeks and find that we are not at all foolish, as the merchants and butchers claim."

Another—

"Our association effects to us a saving of about 65 cents per hundred on hogs and 70 to 75 cents per hundred on cattle and sheep. We have through our organization in this country [community] shipped several hundred carloads of live stock in the last year, and when I say we have made a saving of 50 cents per hundred pounds I am making it low. I might say that in some localities in our country [community] the individual stock buyer is a thing of the past. * * * We think we can show by actual figures that we have distributed among the farmers \$40,000 this year that would not have been received had it not been for cooperation in this one place."

Another farmer, a member of a shipping association which did a business of \$130,000 last year, writes us that thousands of dollars have been saved by this association to the farmer. Judging by the information we have received, a saving of from 30 to 100 per cent has resulted from the work of these societies.

The itemized statements of market prices, expenses, and shrinkage which are rendered to each shipper greatly increase their interest in market quotations and demands. Managers of associations which have been organized for some time state that the quality of live stock in their communities has improved noticeably. The raising of uniform breeds of stock is being encouraged and this is a step toward community breeding.

As an adjunct to the stock-shipping business, cooperative buying is being conducted by a number of associations. Buying is confined principally to the purchase of grain and feeds in carload lots for stock-feeding purposes. Farmers usually haul the feed direct from the cars. Some of the older associations, however, have warehouses where supplies of various kinds are stored and sold to their members as called for. One association reported that during the spring of 1915 it supplied its members with corn at 12 cents per bushel less than dealers were charging, and that considerable amounts were saved in the price of other feeds.

SUMMARY.

(1) Cooperative live stock shipping up to the present time has been confined almost entirely to a few Middle Western States and sections within these States where live stock production is a side line in connection with general or specialized systems of farming operations. The extensive and rapid development of these associations during the seven years since their origin is indicative of marked benefits to their members, and the movement must be recog-

nized as a factor of permanent and growing importance in the marketing of live stock.

(2) Simplicity of organization and the fact that no capital is required make the cooperative shipping of live stock peculiarly adapted to communities in which more complex forms of cooperation would be impracticable. Although not necessarily feasible in all sections, especially those in which live stock generally is marketed in carload lots, or where there is insufficient stock suitable for shipment to market, or where the central markets are not readily accessible, nevertheless there are many communities in various parts of the country which would be greatly benefited by such associations.

(3) The principal requisites to the success of these associations are a competent manager and loyalty on the part of members. It is important that the manager be well known in the community and experienced in marketing live stock. He also should be a man whose reputation in business dealings has been such as to gain the confidence of the farmers.

(4) It is important that all stock be marked at the shipping point. This prevents errors relative to shrinkage and dockages and assists in making proper adjustments in case of loss or damage in transit. Some associations do not mark hogs, but grade them at the shipping point. It is generally considered, however, that better satisfaction to all may be obtained by marking all classes of stock.

(5) It should be the manager's duty to prorate the receipts, expenditures, and shrinkage for each shipment, as from his knowledge of each shipper's stock and from records made on shipping day concerning each he is best prepared, as a rule, to adjust the individual accounts more equitably than can be done by the commission firm.

(6) Wherever these associations have been formed an appreciable saving to the farmer has resulted. The profit that formerly went to the local shipper now goes to the farmer, and he has the satisfaction of knowing that he will receive for his stock the actual market price, less the cost of marketing. Moreover, the activities of a competent manager and the influence of a successful association make for a general improvement in methods of marketing live stock and a better knowledge of market prices and conditions by farmers in the entire community. The beneficial influence thus exerted is of no less importance than the actual saving to members on the shipments handled by the association.

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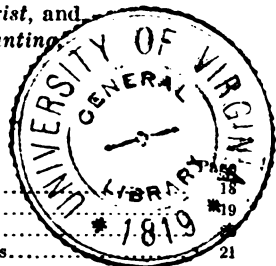
OFFICE OF THE SECRETARY.

Contribution from the Office of Farm Management, W. J. Spillman, Chief.

AN ECONOMIC STUDY OF THE FARM TRACTOR
IN THE CORN BELT.By ARNOLD P. YERKES, *Assistant Agriculturist*, and
L. M. CHURCH, *Assistant in Farm Accounting*.

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Numerous inquiries for information as to the economic value of the gas tractor for farm work are received by the Department of Agriculture from farmers in all parts of the country, and in order to furnish prospective purchasers of tractors with some figures which would be a reliable indication of what might reasonably be expected from these outfits the Office of Farm Management has obtained detailed information from several thousand tractor owners, from all sections of the country, showing just what they are doing in actual service on farms.

From the large number available there have been selected reports from over 200 tractor owners in the State of Illinois¹ whose farms

¹ Most of the reports from which figures were taken for use in this bulletin were obtained during January and February, 1916, though a few were obtained in December, 1915. Over 50 per cent of the outfits reported on were bought during 1915, and no reports were used which related to machines used more than three seasons; from this it will be seen that the data cover only modern outfits. No reports were considered which were furnished by farmers who held agencies for tractors or were otherwise financially interested in the business. The figures should, therefore, represent the opinions of unbiased men.

are typical of corn-belt conditions, and in the following pages are given what are considered the most important facts and figures, from the farmer's standpoint, brought out in the tabulation of the information contained in these reports. Most of the figures have been omitted for the sake of brevity.

Attention is particularly invited to the fact that data on the operation of tractors soon become obsolete because of the changes and improvements which are constantly being made in these outfits, as well as changes in their prices and the prices of fuel, etc. The figures contained herein are correct for conditions as they existed in the spring of 1916, and should be applicable not only in Illinois, but throughout the corn belt, since the farms from which the records herein used were obtained are quite typical, in most respects, of corn-belt conditions in general. Corn is the principal crop grown on practically all these farms, approximately 40 per cent of the entire acreage being planted to this crop. Oats are raised in most cases, the acreage being about one-half as great as for corn, on an average. The next crop in point of acreage is wheat, which is raised to a limited extent on more than half of the farms. Hay, including alfalfa and clover, forms a large percentage of the remaining crops. Both spring and fall plowing is practiced, slightly more ground being plowed in summer and fall than in the spring. The land is mostly level or gently rolling, quite free from stone, for the most part; and while there is a good deal of rather heavy loam the plowing conditions are not severe, except when very dry. The fields are generally regular in shape and range in size from about 20 acres up. (See fig. 1 for labor distribution on a corn-belt farm.)

The above-mentioned facts relative to the general characteristics of the type of farming followed should be kept in mind when considering the figures furnished by tractor owners in this section, as shown in the following summary of the principal facts brought out by a study of the experience of these men as given in their reports:

The chief advantages of the tractor for farm work, in the opinion of the operators, are (1) its ability to do the heavy work and do it rapidly, thus covering the desired acreage within the proper season; (2) the saving of man labor, and the consequent doing away with some hired help; and (3) the ability to plow to a good depth, especially in hot weather.

The chief disadvantages are difficulties of efficient operation and the packing of the soil when damp.

The purchase of a tractor seldom lowers the actual cost of operating a farm, and its purchase must usually be justified by increased returns.

One of the most important points in connection with the purchase of a tractor is to obtain one of suitable size for the farm on which it is to be used. In this connection experienced tractor owners in Illinois make the following recommendations:

For farms of 200 crop acres or less, the 3-plow tractor.

For farms of from 201 to 450 crop acres, the 4-plow tractor, with the 8-plow outfit second choice.

For farms of from 451 to 750 crop acres, the 4-plow tractor, with the 5- and 8-plow outfits tied for second choice.

A farm of 140 acres is the smallest upon which the smallest tractor in common use, the 2-plow outfit, may be expected to prove profitable.

Medium-priced tractors appear to have proven a profitable investment in a higher percentage of cases than any others.

The life of tractors, as estimated by their owners, varies from 6 seasons for the two-plow to 10½ seasons for the 6-plow outfits.

The number of days a tractor is used each season varies from 49 for the 2-plow to 70 for the 6-plow machines.

No definite figures on the repair charges for late model tractors can be given; it would not seem safe, however, to count upon less than 4 per cent of the first cost annually (this representing the average for farm machinery in general).

Under favorable conditions a 14-inch plow drawn by a tractor covers about 3 acres in an ordinary working day. Under unfavorable conditions large gang plows will cover less ground per day per plow pulled than will the small ones.

Two and one-half gallons of gasoline and one-fifth of a gallon of lubricating oil are ordinarily required in actual practice to plow one acre of ground 7 inches deep. The size of the tractor has little influence on these quantities.

Plows drawn by tractors do somewhat better work, on the whole, than horse-drawn plows. In Illinois the depth plowed by tractors averages about 1½ inches greater than where horses are used.

Efficient operation is essential to success with a tractor, and proficiency usually can be obtained more cheaply and easily by previous study and training than by experimenting with one's own tractor.

With a proficient operator the tractor is a very reliable source of power.

The use of the tractor for custom work is usually an indication that the home farm is not large enough to utilize it economically. The doing of custom work with the tractor, on the whole, appears to be a questionable practice, although nearly 45 per cent of machines are used for such work to some extent.

A tractor displaces on an average about one-fourth of the horses on the farm where it is used.

On a large number of Illinois farms brood mares constituted 33 per cent of the work stock before the purchase of the tractor. The use of the tractor increased this proportion only 3 per cent.

Experienced tractor owners do not consider even a 2-plow outfit profitable on a farm of less than 140 acres. The average size of farm on which 2-plow outfits are used in Illinois is 270 acres.

The 4-plow tractor is most recommended by experienced owners.

Both increases and decreases in the crop yields are reported from the use of the tractor, although favorable effects are more common than unfavorable. However, increases are not sufficiently frequent to warrant a farmer placing much dependence on the tractor in this respect.

It should be clearly understood that the figures given represent average results obtained in actual service and not the maximum possibilities of the tractor. These averages are believed to be worth

more to a farmer in determining the possible value of a tractor for his work than are maximum figures from tests no matter how carefully conducted. The latter would represent, at best, only a limited number of machines and conditions, while averages here given represent a large number of machines operated by incompetent as well as competent operators under both favorable and unfavorable conditions. A prospective purchaser may reasonably count upon equaling the average performance of his neighbors. He should strive, of course, to equal the maximum performances of experts, but should not depend upon being able to accomplish like results in order to justify investing in a tractor. For example, an outfit with sharp, new plows, operated by an expert, may plow an acre of ground with, say, one gallon of gasoline, but since under ordinary conditions, with plows that have been sharpened several times and perhaps are not in perfect adjustment, the fuel consumption will ordinarily equal the average given herein, 2½ gallons, it is obvious that the farmer should use the average figure in calculating the possible value of the tractor for his work.

It is not the purpose of this bulletin to influence the farmer either for or against the tractor as a source of power, but only to assist him in determining whether his individual conditions justify the use of such power. The question of whether a tractor will prove profitable on a particular farm is a problem in farm management which must be worked out for each individual farm; in some cases it will prove profitable, while in others it will not, depending upon conditions.

ADVANTAGES AND DISADVANTAGES OF THE TRACTOR.

The theoretical advantages of mechanical power for farm work are obvious but it is believed a prospective purchaser of a tractor would be interested in knowing what the men who have used tractors have found to be their principal advantages and disadvantages in actual practice.

Several hundred Illinois tractor owners were asked the questions; "What do you find to be the principal advantages of a tractor for farm work?" and "What are the principal disadvantages?"

A summary of the replies to these questions discloses the following interesting points:

The ability of the tractor to do the heavy work and to do it quickly, thus covering the desired acreage within the proper season, was considered the principal advantage. The saving of man-labor and the doing away with hired help was placed next. The ability to plow to a good depth, especially in hot weather, was placed third, while economy of operation, the displacement of horses, and the ability to use the tractor day and night were not mentioned by very many owners, although they are usually considered, theoretically, to be decided advantages.

Under disadvantages, difficulty of efficient operation and packing of the ground when damp were the principal points. Expense came next, while delays and inability to use the tractor for many kinds of work for which horses could be used were given by several owners.

While other advantages and disadvantages were mentioned, they were not given by a large number of owners.

ECONOMY.

The fact that reduction in the cost of operating a farm was not emphasized as an advantage of the tractor, while expensiveness is frequently mentioned as a disadvantage, should be carefully considered by a farmer who contemplates buying a tractor with the hope of reducing his present operating expenses.

A comparison of the cost of doing farm work with a tractor with the cost of doing the same work with horses means practically nothing, for the reason that several horses must ordinarily be kept on the average farm even where the tractor is used. Comparisons must, therefore, be made between the cost of operating a farm with horses alone and the cost of operating with a tractor and a certain number of horses.

In any such comparison there are a number of factors which must be considered and which vary widely in different cases. No attempt will be made herein to make direct comparisons, which would, at best, apply to but a very small percentage of cases. Average figures, based on reports of experienced tractor owners, will be given for the various factors, thus enabling a farmer to figure out what he may reasonably expect of a tractor under his own conditions.

In any such calculations, however, it is necessary to consider not only the relative expense with the two methods, but the relative results. The value of such features will vary on different farms; on some they will be very important while on others they will mean little.

SIZE OF FARM AND TRACTOR.

Every improved farm machine reduces the man-labor required for farm operations, thus permitting one man to accomplish more work and so farm more land than with the older methods. However, it is an obvious and well-known fact that a farm business must be of sufficient size to permit of the economical use of an improved machine in order to justify the necessary investment therein. That is, many small farms must either use the old methods or hire a modern outfit, because the small amount of work to be done each year does not warrant owning the machine.

Among the more important facts disclosed by a study of the use of the tractor for farm work are those relating to the increase in the

acreage which can be farmed by one man, when a tractor is used in connection with horses, over that farmed with horses alone. Approximately 75 per cent of tractor owners in Illinois state that the tractor has proven a profitable investment to them. Of this number about one-third, after the purchase of the outfit, increased the acreage which they were farming, the increase averaging about 120 acres per farm. On the other hand, of the men who found the tractor unprofitable, only one-twentieth increased their acreage after purchasing the tractor.

These figures are significant, not only because a large percentage of the men who found the tractor profitable increased their acreage, but also because of the considerable percentage of the entire number of tractor owners who have enlarged their farms, as compared with the smaller percentage of all Illinois farms of comparable size which have increased their acreage in recent years. (See U. S. Census, 1910, Vol. V, p. 276.)

Farm-management studies repeatedly have demonstrated the fact that a great many farms are not large enough to furnish economical employment for the equipment which they possess; that is, the various implements are capable of doing the work on a larger acreage within the time which the seasons allow, and that the purchase or rental of additional land often will increase the gross receipts considerably without increasing the operating expenses to any great extent.

The following figures as to the smallest size of farm on which tractors of from 2 to 5 plow capacity can be profitably used are based on the statements of about 200 tractor owners located in the State of Illinois. (Table I.) The acreages given are the averages of the figures furnished by these men in reply to the question: "What do you consider the minimum size of farm on which a tractor the size of yours can be used profitably in your section?"

TABLE I.—*Minimum acreages upon which tractors are profitable.*

(Averages based on estimates of about 200 Illinois tractor owners.)

Size of tractor. ¹	Minimum size of farm on which it is profitable (owners' estimates).
2-plow	140
3-plow	200
4-plow	250
5-plow	320

¹ In all cases the size of the tractor is referred to by the number of 14-inch plows pulled rather than by the horsepower ratings. This is done for the reason that the different manufacturers do not use a uniform method of rating their outfits, thus making a comparison of the different tractors by their horsepower ratings practically valueless. It is believed that the course here followed of grouping by the number of plows pulled under conditions which are not only fairly uniform but which represent average conditions offers a more reliable comparison than would be obtained by grouping according to the horsepower ratings.

Attention especially is called to the fact that these figures represent the smallest size of farm for which these tractors should be purchased, in the opinion of men who have had experience with them, and not the size on which they can be used most profitably. A farmer who is contemplating the purchase of any particular size of tractor and whose farm is smaller than the acreage above given for that size should consider carefully before acting contrary to the opinions of experienced men.

The average sizes of farms on which tractors of different sizes are being used in the State of Illinois are shown in Table II and are considerably above the minimum figures as given above.

TABLE II.—Average sizes of farms upon which tractors of different sizes are being used.

(Averages based on estimates of about 200 Illinois tractor owners.)

Size of tractor.	Average size of farm.
2-plow	270
3-plow	330
4-plow	365
5-plow	420

While a few of the larger outfits are used the numbers are not sufficient to furnish reliable averages, and, furthermore, such outfits frequently are bought principally for custom work, in which case the size of farm becomes of less importance.

It is necessary that the proper size of tractor be procured in order to obtain the fullest degree of satisfaction. A tractor which is not powerful enough for the work required of it will, of course, prove more or less unsatisfactory, and to exchange it for a larger one entails an expense which would be unnecessary if the right size were obtained in the first place. On the other hand, an outfit which is much too large may be too clumsy or expensive in operation to make it economical for a great deal of work for which one of the proper size could be used with satisfaction and economy.

It is interesting to note, in comparing the data in Table III with that in Table IV, that the 50 Illinois tractor owners having farms of 201 to 300 crop acres had bought outfits varying in size from 2-plow to 10-plow, 36 per cent of them having bought tractors capable of pulling more than 4 plows. Only 8 per cent of them now recommend anything larger than a 4-plow tractor for farms of this size. Eighteen per cent of them originally bought 2-plow machines, but only 14 per cent now recommend this size for their farms. The most significant fact is that while only 46 per cent originally bought 3 or 4 plow outfits, 78 per cent now recommend these sizes.

In Table III are shown the sizes of tractors bought by 146 farmers in the State of Illinois, arranged according to the amount of land being farmed.

TABLE III.—*Tractors of different sizes bought by 146 farmers in Illinois, arranged according to acreage cropped.*

Acres cropped. ¹	Average acres cropped. ¹	Total number of tractors bought.	Percentage of different sized tractors bought.						
			2-plow tractors.	3-plow tractors.	4-plow tractors.	5-plow tractors.	6-plow tractors.	8-plow tractors.	10-plow tractors.
			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
200 or less.....	156	39	33	23	23	13	3	0	5
201 to 300.....	252	50	18	22	24	14	8	12	2
301 to 450.....	361	39	10	18	33	13	16	10	0
451 to 750.....	503	18	5	17	17	33	0	22	6
All purchases.....		146	18	20	25	16	8	10	3

¹ Includes only land actually tilled and planted to crops.

It will readily be seen that there was considerable difference of opinion among these men as to the best size of tractor to buy when they first invested in such an outfit. The 146 machines are pretty generally distributed as to size, both in the individual groups and in the aggregate. It will be noticed that 37 per cent of them were distributed among the 5, 6, 8, and 10 plow outfits, while 18 per cent pulled only 2 plows.

As compared with these figures, it is interesting to note that these same men, after experience with their tractors, have come to a much more definite and uniform opinion as to the proper size of outfit for their farms, as shown by their recommendations set forth in Table IV.

From this it will be seen that only 4 per cent of the farmers with less than 200 acres of crops now recommend anything larger than a 4-plow tractor for this size of farm, although Table I shows that 21 per cent originally bought outfits of larger size. None of them recommends a tractor capable of pulling more than six plows. The 3-plow tractor is recommended by 41 per cent of the owners, while 31 per cent recommend 4-plow, and 23 per cent 2-plow, outfits. In other words, 95 per cent of these men recommend either 2, 3, or 4 plow tractors.

TABLE IV.—*Tractors of different sizes recommended by the 146 tractor owners in Illinois shown in Table I.*

Acres cropped. ¹	Average acres cropped. ¹	Total number of recommendations.	Percentage of different sized tractors recommended.						
			2-plow tractors.	3-plow tractors.	4-plow tractors.	5-plow tractors.	6-plow tractors.	8-plow tractors.	10-plow tractors.
			<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
200 or less.....	156	39	23	41	31	2	2	0	0
201 to 300.....	252	50	14	32	46	2	4	2	0
301 to 450.....	361	39	8	21	28	13	10	10	0
451 to 750.....	503	18	0	11	29	22	6	22	0
All recommendations.....		146	13	29	29	8	5	6	0

¹ Includes only land actually tilled and planted to crops.

The figures for the group of farmers with from 201 to 300 acres of crops already have been referred to, and the conclusions to be drawn from those for the last two groups are similar to those mentioned for the first two, although the percentage of men recommending the larger sizes of tractors naturally increases with the additional acreage, while that for the smaller sizes drops off correspondingly, no one recommending the 2-plow tractor for farms having over 450 acres of crops.

The principal points relating to the best size of tractor as brought out by the experience of tractor owners in Illinois as shown in Table IV may be briefly summarized as follows:

For farms having 200 acres, or less, of crops, a 3-plow tractor is considered the most desirable, while a 4-plow outfit would probably be better on this size of farm than one pulling only 2 plows.

For farms having from 201 to 300 acres of crops a 4-plow outfit is generally believed to be most suitable, while either a 3 or 2 plow machine would be better than one pulling more than 4 plows.

For farms having from 301 to 450 acres of crops the 4-plow tractor is also the favorite, although a larger outfit would probably be more satisfactory than a smaller one.

For farms of 451 to 750 acres of crops the 4-plow tractor is again given a slight preference, although the 5 and 8 plow sizes are each recommended by 22 per cent of the tractor owners in this group, while none recommends the 2-plow, and only 11 per cent favor the 3-plow machines.

Judging by figures obtained at the beginning of 1916, slightly more 3-plow tractors were sold in Kansas and Illinois during 1915 than any other size. The 2-plow outfits were a close second, with the fours third, but some distance behind either the threes or twos.

It should be mentioned, however, that these machines were grouped according to the number of plows pulled in actual practice, as given by the farmer, which resulted in placing some makes of tractors of exactly the same size partly in one group and partly

in another, rather than including them all with the same size according to the manufacturer's rating. From the figures thus obtained it appears that the percentages of different sized tractors bought in Illinois and Kansas during the past year were approximately as shown in Table V, assuming that the number of outfits on which records were obtained is a reliable indication of the percentages of the total numbers.

TABLE V.—*Tractors bought in Illinois and Kansas in 1915, classified by size (194 reports).*

Size of tractors.	Percentage bought.
2-plow.....	30
3-plow.....	42
4-plow.....	16
5-plow.....	6
6-plow.....	3
8-plow.....	2
10-plow.....	1

As compared with these figures, the percentages of different sizes recommended by the men who have had experience with tractors are shown in Table VI.

TABLE VI.—*Tractors recommended by 146 owners, classified by size.*

Size of tractors.	Percentage recommending.
2-plow.....	13
3-plow.....	29
4-plow.....	39
5-plow.....	8
6-plow.....	5
8-plow.....	6
10-plow.....	0

Particular attention is invited to the decrease in the percentage of 2 and 3 plow tractors recommended as compared with those bought, and the corresponding increase in the percentage of 4-plow outfits recommended over the same size bought.

It is significant that the 4-plow tractors give more general satisfaction in Illinois than any other size, as indicated by the percentage of favorable reports from their owners, as shown by Table VII.

TABLE VII.—*Favorable reports, classified by size of outfit (99 reports).*

Size of tractor.	Percentage of owners reporting the tractor a profitable investment.
2-plow.....	70
3-plow.....	73
4-plow.....	86
5-plow.....	76
6-plow.....	82
8-plow.....	82
10-plow.....	60

Where modern self-lifting gang plows are used, one man ordinarily handles the entire outfit in plowing no matter what size gang is used.

The 4-plow size seems to meet best the tractor requirements of the average farm in Illinois; it enables plowing to be performed at a much faster rate than is usual when horses are employed. The man-labor is also reduced when using this size tractor, as one man attends to four plows at one time, instead of only two, as is ordinarily the case where horses are used. Furthermore, this size of tractor is generally powerful enough to operate practically all of the machines which are commonly found on the average farm, including the ensilage cutter and medium-sized grain separator. At the same time it is not too expensive in operation to prohibit its use for many odd jobs which do not demand a great deal of power. These facts probably account, to a great extent, for its popularity.

There are, of course, factors other than the size of farm which must be considered in order to determine the best size of tractor to buy, and mention will be made of them in the following paragraphs. In cases where these factors do not exist or are of no effect, however, it would seem advisable to procure the sizes of outfits recommended by men who have had experience with tractors on farms of practically the same size, provided, of course, that the conditions were similar in each case. In this connection attention is particularly invited to the general type of farming followed by the men whose figures are shown herein, as mentioned on page 2.

In deciding as to the size of outfit to purchase, careful consideration should be given to the various jobs for which the tractor will be used, and care exercised to obtain one with ample power for the heaviest work which will be required of it. This may be either field or belt work; probably it will be the latter more often than the former. Quite frequently the work of a tractor in driving a grain separator or ensilage cutter requires more power than the plowing, and in such cases the tractor bought should be powerful enough to handle the belt work properly.

On the other hand, if the belt work which will be required of the tractor will not demand a great deal of power, while there may be a considerable amount of plowing which it will be desired to complete within a limited season, the tractor should be capable of pulling enough plows to enable the work to be performed within the time available.

Then, too, there are cases where only a small amount of belt work is required and most of the field work will be done with horses, the tractor being wanted merely to make extra power available in rush seasons, or to relieve the horses during hot spells. In such cases the small 2-plow outfits frequently have proven most satisfactory. Such an outfit has the additional advantage of not necessitating a large

investment, and on this account is frequently recommended by experienced men as a good size to buy at first, in order to gain experience in the use and care of tractors.

If it is desired to use the tractor for custom work on neighboring farms or for road work, the power requirements for such work should be ascertained and care exercised to choose an outfit with sufficient power to handle the work satisfactorily.

As a general rule it is better to err through buying an outfit with too much power rather than too little, but this should not be interpreted as recommending the purchase of the largest sizes. It refers rather to the too common practice of getting a 2-plow outfit to do work which should properly be done by a 4-plow machine. The decrease in the percentage of men recommending 2-plow tractors, as shown in Table IV, compared with the percentage of men who bought this size, as shown in Table III, is perhaps as significant as the increase in the percentage recommending 4-plow outfits in comparison with that recommending larger sizes.

COST OF TRACTOR OUTFIT.

While the cost of a tractor should not be the prime consideration, it is one of the first points which a farmer must consider. The prices of the various makes of outfits vary considerably for machines of the same capacity. The figures given in Table VIII are averages for a considerable number of each size, but it should be borne in mind that some makes will cost more than the prices shown, while others will be less.

TABLE VIII.—*Cost of tractor outfits (148 reports).*

Size of tractor.	Cost of complete outfit.	Cost of tractor.	Cost of plow.	Cost per plow pulled.
2-plow	\$554	\$501	1 853	\$277
3-plow	1,262	1,086	176	421
4-plow	1,560	1,296	264	399
5-plow	2,034	1,653	381	407
6-plow	2,352	1,962	390	392
8-plow	2,798	2,212	586	350

¹ Many farmers use a horse gang plow with the small outfits, and as these cost less than a 2-bottom engine plow it makes the average price of the plows lower than for ordinary 2-bottom engine gangs.

The price which a farmer can afford to pay for a tractor¹ for use on his farm depends upon a number of factors, and this is another point on which no definite figures can be given at the present stage of tractor development. However, it is particularly interesting to note that the outfits costing between \$500 and \$1,200 have proved profitable in a somewhat greater percentage of cases than either lower or higher priced machines. This was shown by grouping the reports of tractor owners according to the cost of the outfit, as given in Table IX.

TABLE IX.—*Favorable reports, classified by cost of outfit (147 reports).*

Outfits costing between—	Percentage of owners reporting them profitable.
\$355 and \$500.....	71
\$501 and \$700.....	82
\$701 and \$900.....	88
\$901 and \$1,200.....	86
\$1,201 and \$1,500.....	77
\$1,501 and \$1,800.....	72
\$1,801 and \$2,850.....	73

These figures would seem to indicate that a farmer who pays more than \$1,200 for a tractor will find it comparatively difficult to make it profitable, while buying exceptionally low-priced outfits frequently does not pay, partly because they are often cheap in quality as well as in price, and partly because they are too small to do the work economically.

It is interesting to compare these figures with those appearing on page 10, giving the percentage of favorable reports for different sizes of tractors.

LIFE OF THE TRACTOR.

The number of years a tractor will be of service is, of course, an important factor in determining its value for farm work.

Gas tractors have been on the market such a short time that it is obviously impossible to obtain any very definite figures as to just how long a modern tractor may be expected to last on a farm.

The average of the estimates of about 200 owners of comparatively new tractors in Illinois as to the length of time their outfits will give satisfactory service is 8 years. These estimates, of course, can not be accepted as of much value and are in reality probably overestimates. While present-day tractors are perhaps better made than those of a few years ago, it is to be noted that tractors that have been worn out did not on the average last 8 years. It would at least be on the side of safety for a prospective purchaser to count on a shorter period of service than 8 years. It should be borne in mind that the men making these estimates probably assumed that it would be possible to obtain repair parts for their outfits at any time. Judging by past experience in the tractor field, however, quite a number of the concerns now in the business will have ceased to exist 5 years hence, and repair parts for still other machines will not be obtainable except at exorbitant prices even if the manufacturers are still in the business, as new designs will have been adopted, and it will not pay to keep spare parts for old outfits in stock except in cases where they have been sold in large numbers.

From Table X it will be seen that the estimated life of the small tractors is less than for the large ones.

TABLE X.—*Estimated life of tractors (132 reports).*

Size of tractor.	Average of estimates of owners as to probable length of service.
	Years.
2-plow.....	6
3-plow.....	8
4-plow.....	8½
5-plow.....	9
6-plow.....	10½

Just how much weight should be given to these figures is difficult to determine, but, as before stated, they are probably of little value. However, the figures as to the average number of days the different sizes of tractors are used per year should be quite accurate, as these are not estimates, but known numbers (Table XI).

TABLE XI.—*Average number of days used per year (96 reports).*

Size of tractor.	Number of days used during year.		
	At custom work.	On home farm.	Total.
2-plow.....	3	46	49
3-plow.....	3	46	49
4-plow.....	7	53	60
5-plow.....	26	40	65
6-plow.....	81	39	70

From these figures it will be seen that the large sizes are used fewer days on the home farm, but a much greater number at custom work than are the small outfits, indicating that the farms on which the large ones are used (see page 8) are too small to furnish them economical employment.

These figures probably will appear low, at first glance, but when it is remembered that on farms where horses do all the work they are used, on an average, only about 100 days annually, it will be seen that where both horses and tractor are used, even though the number of horses is somewhat reduced, the tractor will not have employment for as many days annually as did the horses. The horses kept will do some of the work, which will, of course, decrease the amount to be done by the tractor. But if the tractor did all the work formerly done by the horses it would not normally be employed 100 days per year, inasmuch as it does the work faster. It should be

remembered that practically all farm operations must be carried on within limited periods, and that between these seasons there will often be no field work which the tractor can do, either on the home farm or for neighbors. The fact that weather and soil conditions are such as to permit of field work with a tractor does not mean that there is such work to be done. Farm management plays an important part in organizing the farm so as to provide employment for the tractor during as many days as possible. Such organization involves the planning of a crop rotation which will furnish a large amount of work which the tractor can do, the elimination of a maximum number of horses, and the distribution of the work over a long period. However, the rotation should include only such crops as can be grown at a profit in that particular section. The desirability of having more land where a tractor is used than where horses only are employed, in order to keep the tractor busy during the limited working seasons, will be readily apparent when considering the tractor's place in farm management.

In Table XII is shown the estimated average life of the different sizes of tractors in terms of total number of days of use based on the figures given in Tables X and XI.

TABLE XII.—*Estimated average life of tractors in days of service.*

Size of tractor.	Average life in days.
2-plow.....	294
3-plow.....	392
4-plow.....	510
5-plow.....	585
6-plow.....	735

REPAIRS.

Any figures on the expense of keeping a tractor in repair are of necessity very general. The amount of repairs required depends upon a great many factors, such as the nature of the work, the care the outfit receives, both when used and when idle, etc. Most tractors are kept in repair by the manufacturers during the first year's service excepting for such items as are caused by some fault of the operator. It is not until the second year, therefore, that the owner bears the full expense.

Of 99 tractor owners in Illinois who had used their outfits one season or less 52 reported that they had spent nothing for repairs. The others had had repair bills varying from a few cents to a hundred dollars or more. Very few machines go through their second season without repair charges, the amount depending somewhat,

of course, upon the size and cost of the machine. The figures thus far obtained on the cost of repairs would seem to indicate that the repairs on the 2-plow outfits are slightly higher in proportion to first cost than those for the 3 and 4 plow machines. It would appear also that the average repairs borne by tractor owners the first year will amount to approximately $1\frac{1}{2}$ per cent of the first cost of the tractor, while for the second year they are about double this figure.

Figures on the repairs required by any machine during the first two years of its life, however, are of little value, as with most farm machines the repairs are comparatively low during the first two years, but maintain a fairly constant percentage thereafter.

The average percentage of the first cost of farm machinery in general which is expended annually for repairs is slightly over 4 per cent,¹ and it is improbable that the annual repairs required by a tractor during its life would fall below this figure. This would mean a total expenditure for repairs, during the eight years reported by operators as the tractor's life, equal to 32 per cent of its first cost.

WORK DONE PER DAY.

The amount of land covered per day by a plow drawn by a tractor is usually slightly greater than that covered by a horse-drawn plow. The acreage covered by two different machines, each pulling the same number of plows, often varies considerably because they travel at different speeds. Theoretically a 14-inch plow when drawn by a tractor should cover approximately 3 acres in an ordinary working day of 10 hours, as the average plowing speed is slightly more than 2 miles per hour. This will hold true in actual practice when the plowing conditions are favorable, provided the outfit does not give trouble. That is, a 2-plow machine should plow 6 acres and a 10-plow outfit 30 acres per day, provided both travel at the average rate of speed and are kept moving. However, under conditions where trash is to be turned under, and frequently clogs the plows, or where other obstructions cause delays on account of the plows, each plow drawn by a large tractor will cover much less ground in a day than one drawn by a small outfit, because the delays will naturally be in proportion to the number of plows pulled. A delay on account of 1 plow on a 2-plow outfit stops only 1 other plow, while on a 10-plow rig, for example, it stops 9 other plows. To illustrate, supposing a man operating a 2-plow tractor was compelled to stop 10 times during a day for each plow, in order to clear it of trash, and spent three minutes each time (which would not be unusual), the loss of time during the day would amount to a half hour

¹ See U. S. Department of Agriculture Bulletin No. 338.

for each plow, or but one hour total loss. Each plow would have done nearly as much work as in plowing continuously. On the other hand, a man operating a 10-plow tractor under the same conditions would have to clear each plow the same number of times in proportion to the acreage covered, resulting in a total loss of three or four hours during the day. In such case each plow would have done much less work than under favorable conditions.

In view of these facts it is apparent that when plowing under unfavorable conditions large gang plows do not cover as much ground per day per plow as do the smaller ones. However, one man accomplishes considerably more work with the large outfits, even under such conditions.

In Table XIII are given some figures showing the average acreage covered by different-sized outfits in Illinois, as recorded by farmers, which indicate what should be expected under average corn-belt conditions, where there is more or less material to be turned under. It will be noticed that the decrease in the acreage per plow is somewhat irregular. This is due to the fact that in some of the groups certain makes predominate and the average acreage covered corresponds with the speeds of these outfits; that is, where most of the tractors travel at comparatively high speeds the acreage covered per plow is high and vice versa.

Another influencing factor is that in some of the groups figures have been included for machines which the owners are requiring to pull one more plow than should be demanded of them, and which do not cover as much ground as should be covered by a machine in the same group which is pulling a normal load. It does not pay to overload a tractor any more than it does to overload a horse. Three plows behind a 2-plow tractor will cover only a little more ground, as a rule, than will the two plows, because the tractor usually will travel a little slower, partly because the motor is overloaded and does not maintain its proper speed, and partly because the drive wheels will slip more with a load heavier than the machine was designed to pull; as a consequence delays on account of small holes or slight grades will be more common, as will also mechanical difficulties. These remarks apply particularly to the 2 and 3 plow tractors; the 3-plow group contains some machines which were not designed to pull 3 plows, but which have been included because the owners are using them with that number. The 2-plow group contains some of the same make and are doing nearly as much work. This group also includes several outfits which travel considerably faster than the average.

TABLE XIII.—Average acres covered per day and per plow, by the several sized outfits working under Illinois corn belt conditions (145 reports).

Size of tractor.	Acres covered per net day of 10 hours.	Acres covered per day per plow.
2-plow.....	6.7	3.4
3-plow.....	8.2	2.7
4-plow.....	10.4	2.6
5-plow.....	12.6	2.5
6-plow.....	15.3	2.5
8-plow.....	20.2	2.5
10-plow.....	23.0	2.3

FUEL AND OIL CONSUMED IN PLOWING.

The average amount of fuel consumed in plowing an acre of ground with a tractor in Illinois as reported by tractor owners is slightly more than 2½ gallons. The size of tractor seems to have little influence on the amount required, or on the quantity of lubricating oil used, the latter averaging approximately one-fifth of a gallon per acre. The depth of plowing averaged very nearly 7 inches.

Gasoline is used as fuel by most of the tractor owners in Illinois, the average price paid for same during 1915 being 12 cents per gallon, while lubricating oil averaged 32 cents per gallon.

At these prices the cost for gasoline and oil per acre would be about 36 cents, but the prospective purchaser of a tractor should not make the mistake of assuming that this will be the entire cost, and furthermore, he should remember that the price of gasoline was exceptionally low during 1915. At the beginning of 1916 the average price in Illinois was in the neighborhood of 18 cents, or 50 per cent higher than the figures above mentioned. At 18 cents, the cost of gasoline per acre would be 45 cents, to which should be added about 6 cents for oil, or a total of 51 cents for fuel and oil.

Kerosene for fuel is used to some extent, but is not reported to be as satisfactory in the majority of small outfits as it was in the larger ones used a few years ago. Even where used the amount consumed for a given amount of work is usually greater than for gasoline, thus tending to offset the difference in price. As a rule a little more difficulty in operation is experienced where kerosene is used, and slightly more time is lost per day.

QUALITY OF WORK.

Forty-eight per cent of tractor users report that the quality of the work done by the tractor is better than that done by horses, 46 per cent state it is the same, while only 6 per cent report that it is poorer. This applies principally to plowing. Forty-one per cent of owners in Illinois consider tractors unsatisfactory for use on plowed land, while 59 per cent state they are satisfactory for such work.

The quality of work done in plowing does not depend so much upon the tractor as upon the plow and its adjustment. Under aver-

age conditions the work done by most engine gang plows when properly adjusted is fully equal, if not superior, to the work done by either a walking or gang plow drawn by horses and operated by a skillful plowman. If a job of plowing where a tractor is used is not satisfactory, it is not usually the fault of the tractor but of the plow or, more probably, due to misadjustment of the plows. Of course, in fields with obstructions, sharp angles, etc., the tractor may be responsible for poor work because of its clumsiness, but under most conditions the plows and the operator determine the quality of the work done. The tractor's part is to furnish the power to pull the plows.

This point should be kept in mind by farmers who select their tractors by visiting demonstrations of different makes of outfits. The quality of the work done by the different machines should be of value in selecting a good *gang plow*, but it is practically worthless in determining the value of the different *tractors*. It is quite possible that a tractor of very inferior quality may be pulling a good gang plow, well adjusted, and doing much better work than an outfit of first-class quality which is pulling a poor plow, or one that is out of adjustment.

The average depth of plowing done with tractors in the State of Illinois, as reported by their owners, is slightly less than 7 inches. The average depth they had previously plowed with horses was about $5\frac{1}{2}$ inches. While this deeper plowing is ordinarily considered as indicating a better quality of work, it does not appear to have had any marked effect on the crop yields, as mentioned elsewhere.

OPERATION.

In view of the fact that difficulty in operation is mentioned by tractor owners as the principal disadvantage of the tractor, as shown on page 5, it seems pertinent to state that while any man of ordinary ability can operate and care for a gas tractor very satisfactorily after a little study and experience, it is decidedly unwise for him to undertake to gain the necessary experience by experimenting with his own machine. In most cases he can obtain the experience more cheaply elsewhere. Experience in running stationary engines or automobiles, while of some value, is not enough; the mere starting of the motor, changing of gears, and stopping are simple matters, and any farmer can quickly learn to do these, but the important thing is the ability to detect trouble the minute it begins to develop, and to be able to remedy it promptly instead of allowing it to run along until an expensive delay results.

A great many owners report that it is extremely difficult to get hired help capable of operating a tractor satisfactorily. Where a tractor is to be operated by hired help it is very important for the

owner to understand the proper care of the outfit in order to see that it is not abused.

The fact that a tractor does demand a certain amount of knowledge on the part of the operator can scarcely be considered a disadvantage, inasmuch as the necessary training can be obtained easily and at a very nominal expense. It is to be regretted that so many men will ignore the opportunities for equipping themselves for the proper operation of a tractor before attempting to run one.

That it pays to spend a few days in gaining experience under a competent instructor is attested by a great many tractor users. That it is unwise to attempt to run a tractor without such preparation has also been demonstrated many times. One farmer writes:

I had no experience with the tractor when I started and would have made \$500 more during the season, if I had had the same experience when I started in the spring as I had in the fall when I quit.

Many others could truthfully make similar statements.

With the increasing use of tractors, as well as of automobiles and stationary engines, farmers are rapidly becoming familiar with the care and operation of gas engines. At the same time tractors are being improved and simplified, so that difficulties in operation are growing less each year. One generation of well-trained and competent operators will disseminate information so that future generations will acquire knowledge on the subject as unconsciously, yet as thoroughly, as the average farmer's son acquires his knowledge of horses.

The mistake should not be made of assuming that any boy can operate a tractor in an efficient manner; it is a job which only a proficient operator can handle properly.

RELIABILITY.

The reliability of a tractor depends very largely upon the ability of the operator. Of about 200 tractor owners in Illinois, 57 per cent report that their outfits were not out of commission a single day when needed during the past season. Of the remaining 43 per cent, the average number of days their tractors were out of commission when needed was 7. This average, however, does not include the experience of 7 men who stated their machines were out of commission nearly all the time and one who said half the time.

The reports of tractor owners indicate that with a careful and proficient operator a gas tractor is a very dependable source of power; occasional slight delays probably will be encountered, but serious ones will be exceptional. With a careless or incompetent operator, serious delays are apt to be frequent.

About 90 per cent of tractors in Illinois are operated by the owner or some member of his family. The reports of these men show.

that an average of about three-fourths of an hour is lost per day on account of trouble with the tractor itself.

DISPLACEMENT OF HORSES.

Many men look to the tractor to enable them to do away with the use of horses for farm work, at least in great part. To date, however, the tractor has not displaced horses to the extent commonly expected by purchasers, but its greatest advantage, as before mentioned, lies in the fact that it does the heavy work quickly, and thus completes it within the proper season, since it places at the farmer's command a large amount of power when needed.

The tractor does displace horses to some extent, but only in about two-thirds of the cases where it is used on the same number of acres previously farmed. In these instances the horses displaced average only about four, and represent slightly less than 50 per cent of the cost of the tractor outfit. The number of horses displaced does not appear to vary to any great extent with the size of the outfit, about as many horses being laid off after the purchase of a small outfit as after buying a large one. The number will vary under different conditions, however, the principal influencing factors being the number of acres farmed per horse and the distribution of the work throughout the year. In the corn belt, horses are seldom displaced on farms where the average tilled acreage per horse is 30 or more. On the farms in Illinois where horses were displaced by the tractor, one horse had been kept for each 20 acres of tilled land. After the purchase of the tractor one horse was kept for each 30 acres of tilled land, or approximately the same as on farms on which no horses were displaced.

There is much work on most farms for which it is neither practicable nor profitable to use the tractor. This is especially true in the corn-belt section, where cultivating frequently requires more power at one time than any other farm operation. Few, if any, tractors, according to reports received, are utilized for such work with entire satisfaction, and it is, therefore, necessary to retain a considerable number of horses after the tractor is bought.

In figure 1 is shown the distribution of horse labor on a typical corn-belt farm, from which it will be seen that the peak load, that is, the greatest amount of work, comes about the end of May, which is the season when corn cultivating is at its height.

On 92 Illinois farms where no change in the acreage was made after the purchase of the tractor, an average of 12 horses per farm had previously been kept. Two hundred and sixty-three horses were displaced on these farms, an average of not quite three horses per farm. On 31, or about one-third of these farms, no horses were laid off.

The raising of colts is an industry of considerable importance on farms in the corn belt, and it would seem natural to expect that where tractors were bought and the work stock thus relieved of the heavy field work the percentage of brood mares kept would be increased, and that the chances of raising more and healthier colts would be enhanced. It was found, however, that on a large group

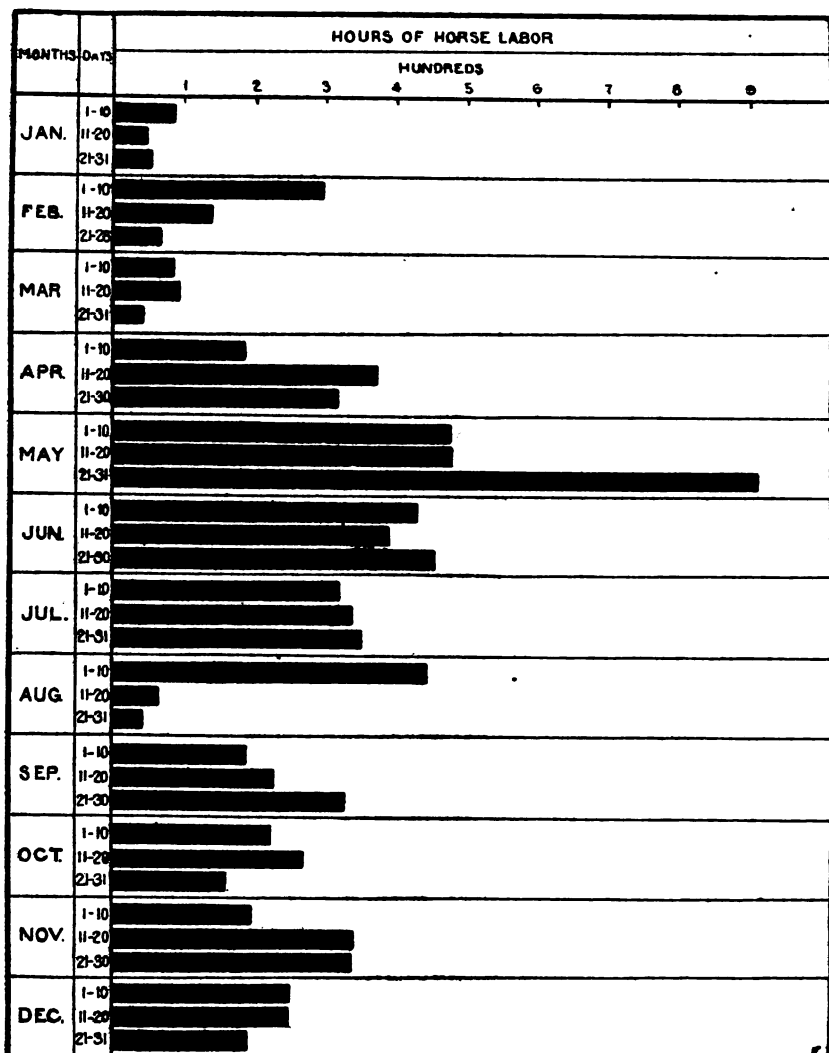


FIG. 1.—Showing distribution of horse labor on a typical corn-belt farm (in Illinois) of 200 acres, with about 120 acres of corn, 45 of oats, and 30 of hay (11 horses).

of farms in Illinois the brood mares constituted 33 per cent of the work stock before the tractors were bought, and while the work stock was decreased to some extent after the purchase of the tractor, the percentage of brood mares increased only 3 per cent, making the percentage now kept amount to 36 per cent.

CUSTOM WORK.

Forty-five per cent of Illinois tractor owners reporting use their outfits for custom work to some extent. A great many of them bought their outfits with the idea of using them for such work, while others procured them for use on their own farms only and undertook custom work at the request of neighbors or because it seemed to offer an opportunity for the tractor to help pay for itself.

In some cases a farmer is justified in using his tractor for such outside work. On the whole, however, it is a rather reliable indication that the home farm is not large enough to utilize a tractor economically.

There would even seem to be some doubt as to whether it pays at all to use the tractor for custom work. Of the 45 per cent of Illinois owners reporting who used their tractors for custom work, one-third stated that it did not pay them to do custom work. It should be noted, too, that comparatively few farmers consider their entire expenses when figuring the profits from custom work, most of them ignoring depreciation charges and including only fuel, oil, labor, and such repairs as may be required during the time the outfit is used at such work.

On the whole, it is preferable that the machine be kept busy on the home farm, where the owner may derive the maximum profit from it. Certainly a tractor owner is not justified in neglecting his own work to work on neighboring farms at the rates usually paid, yet such practice is not uncommon. Most of the custom work done with tractors in Illinois, however, is belt work, and is done principally during slack seasons.

The data show that nearly all of the custom work is done with outfits of medium or large size owned on farms of comparatively small size, the smaller machines not being powerful enough for most of the belt work offered, and those on the larger farms being kept busy at home.

EFFECT OF USE OF TRACTOR ON CROP YIELDS.

The reports of corn-belt tractor owners who have used their outfits for three seasons would indicate that although the yields are occasionally increased by having the plowing done at the proper time and by deeper and more thorough preparation of the seed bed in hot weather, such results are too infrequent to warrant a farmer in depending upon this feature to any great extent, especially in view of the fact that decreases also occur occasionally on account of the packing of the soil when damp. Increases in yields are most frequent with wheat, partly because timeliness in plowing has more effect on its yield than on other crops and partly because it usually does best in a firm seed bed.

Although the depth of plowing done with the tractor averages about $1\frac{1}{2}$ inches greater than that done with horses, this seems to have had, as mentioned elsewhere, a negligible effect on yields. This is perhaps somewhat contrary to what is generally expected, but is doubtless accounted for by the fact that deep plowing alone does not necessarily increase the yields, other good farming methods and practices being required in connection therewith in order to make it profitable.

TRACTOR EQUIPMENT.

The tractor has not yet passed the stage of rapid development which most new machines undergo; in fact it has not progressed far enough to reach the stage of general elimination of outfits of poor design in favor of a standard type. Nevertheless, many of the outfits now on the market are proving profitable to men who are using them. At the same time the tractor is making rapid progress—so rapid, in fact, that field equipment for use with it, with the exception of gang plows, has not kept pace with such development.

It is obviously impossible to obtain maximum results with a tractor when it is used with implements designed primarily for use with horses, and the objection of many tractor owners that the tractor can not be used with profit for certain types of field work will probably cease to hold good in the near future. There is every indication that there will soon be available farm implements designed especially for use with the tractor which will increase its value for farm work, making it practicable and economical for many kinds of field operations where it is now both impracticable and uneconomical.

This is evidenced by the many innovations in harvesting machinery and other attachments, designed to be used on the tractor as a unit, rather than drawn as separate units in the manner followed when horses are used. While this should not be considered as a recommendation of attachments the utility of which has not yet been demonstrated, there would seem to be little doubt that the development of equipment specially designed for use with the tractor, together with the standardization of design and reduction in price which normally result from manufacture in quantity, will greatly enhance the value of the tractor for farm work.

In accord with the purpose of this bulletin, it is not desired to draw conclusions from the facts and figures as given in the preceding pages, but to leave it to the farmer himself to calculate the probable value of a tractor for use on his particular farm. As previously stated, it is not the purpose to influence the farmer either for or against the tractor as a source of power, but only to enable him to judge whether his individual conditions justify the use of such power.

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Contribution from the Bureau of Animal Industry, A. D. Melvin, Chief.

PREVENTION OF LOSSES OF LIVE STOCK FROM PLANT POISONING.

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INTRODUCTION

For many years it has been known that the losses of live stock on the ranges of the West were heavy, but recently, through the increased value of the stock and the resulting more careful attention to the sources of loss, the owners have appreciated more fully the important rôle played by poisonous plants in reducing the profits from range animals. Infectious and contagious diseases on the open range do comparatively little harm, while the losses from predatory animals sink into insignificance when compared to the disastrous effects of poisonous plants. The data are not sufficient for an estimate of the total annual loss, but innumerable instances of the heavy toll taken on individual herds where poisonous plants are common might be cited. Loco losses of from 5 to 50 per cent are not at all unusual; deaths of cattle from larkspur up to 10 per cent are quite common; while losses of sheep from death camas

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or lupine frequently run from 10 per cent up to 50 or 60 per cent. These losses occur, not occasionally, but continually. While in some years the toll is heavier than in others, yet every year has its story of these deaths. There is, in fact, nothing that interferes to such an extent with the success of handling live stock upon the ranges as the problem of dealing with poisonous plants.

This subject has been under investigation by the United States Department of Agriculture for a number of years and reports have been issued in regard to special plants. The investigation has proved to be a slow and somewhat difficult matter, for it is not simply a question of proving whether a plant has poisonous properties or not, but in addition to this it must be shown whether it does any harm under range conditions; the actual effect of the plant on range animals must be demonstrated, autopsies made, and extended experiments must be conducted on remedies and antidotes. A number of plants have been studied in this way; the conditions under which poisoning may take place have been determined; extended experiments have been made on possible antidotes and methods of preventing losses; and a number of papers have been published giving the results of this work and indicating ways in which the losses may be diminished.

In the course of this experimental work it has become increasingly evident that while detailed investigation is fundamentally necessary, and while much can be accomplished by the application of such remedies as have been found experimentally to be effective, the main reliance, from the practical economic standpoint, must be placed on prevention. The more definite information which has been acquired in regard to the plants themselves has shown that some are poisonous only at certain seasons or under certain conditions. Some never injure certain classes of domestic animals although they may cause heavy losses of others. While definite remedial measures can be used in regard to some forms of poisoning, in regard to others no medical remedy has been found practicable, even after very extended experiments.

Moreover, it has become clear that certain modifications of the ways of managing the range and handling the animals can be formulated, which will make a material reduction of the losses. These modifications are not in all respects new discoveries, for some of them are recognized with more or less clearness by many who are engaged in the problems of range management. This recognition, however, has not been general, the principles have not been definitely stated, and they are not commonly applied in the practical use of the range.

These modifications, which will apply to poisonous plants in general rather than to special cases, have been shown to be desirable as

the result of extended observation and experiment on many ranges in the course of several years' work. Although the subject of so managing the range and so handling the stock as to prevent losses is a complicated one, and when worked in detail must mean definite plans adapted to the local conditions of particular ranges, yet it has become more and more evident that there are certain changes which will apply in principle, if not in detail, to all ranges. These principles, it is thought, should be brought to the attention of stockmen and administrative officers of the range country, even if much work remains in order to make a complete study of the subject; for it is evident that any information which will aid in reducing losses should be published as soon as possible.

ERADICATION OF POISONOUS PLANTS.

The question naturally arises whether it may not be possible to do away with all trouble by destroying those range plants which are productive of harm. A number of ways by which this may be accomplished suggest themselves. Among them are the following:

Crowding out by other plants.—It has been thought possible to crowd out some of the poisonous plants by reseeding the range to desirable grasses. While this is theoretically possible, range experience does not give much hope in regard to successful results. As a matter of fact these poisonous plants, as a rule, seem very well adapted to their environment and are likely to hold their own against any introduced plants.

Chemical destruction.—Somewhat extensive experiments were tried in the loco investigation with the hope of finding some cheap substance which would kill loco without injury to other vegetation. These experiments were unsuccessful. It is, of course, not difficult to find substances that will kill all the vegetation, but, apparently, although a great deal of work has been done by many authors on the chemical destruction of weeds, there has been little success in finding a substance that will act in a selective way upon any plants, except the Cruciferae. It therefore seems probable that little can be expected from any attempt to kill out poisonous plants by chemical means.

Close grazing.—In the case of some plants which are injurious to some animals but harmless to others, something may be accomplished by close herding of the animals that are not susceptible of injury. If sheep are close herded on low larkspur, they will accomplish a good deal in the destruction of this plant, for they will clear out the plant very effectively for the time being. Too much must not be expected from this, however, for the larkspurs are perennials and are not easily exterminated.

Destruction of plants by digging out.—This method, so far as our present knowledge goes, is the most effective way of getting rid of the plants and has been proved experimentally to be profitable, within certain limitations. If pastures are under fence it pays well to dig out loco plants. While the ordinary white loco or rattle weed¹ has a root extending down several feet, it can be killed by cutting it off below the crown of buds. If it is cut 2 or 3 inches below the surface the plant is destroyed. This cutting should be done when the plant is in blossom and before it has an opportunity to ripen its seed. A man using a spade can work very rapidly, and the expense of clearing a quarter section or a section is comparatively small. Of course this work has to be repeated to destroy the seedlings, for the loco seed will remain dormant in the soil for several years. The possibility of thus effectively clearing land of loco is not simply a theory but has been proved by actual experiment on land that has been under observation for a period of years. It is not only possible to clear the land, but this method is a success economically.

The tall larkspurs, which cause such heavy losses of cattle, frequently grow in masses in box canyons or about springs where cattle are apt to congregate. Many places of this character have been for a long time known to cattlemen as "poison spots," although the cause of the poisoning has not always been recognized. In many of these places it is entirely feasible to grub out the larkspur, the price of one or two steers paying for a large amount of work. This method, however, is not one of universal application, for on many ranges the larkspurs grow scattered over such a wide area, growing upon rocky hillsides or in the willows in the valleys, that the expense of eradication is more than the range is worth. But with the limitations indicated this method may be used very successfully. It must be remembered, also, that much may be accomplished without the total eradication of the plant if the thick masses which the cattle are most likely to get at are cleaned out, for the animals are not poisoned unless they eat a considerable quantity of the plant.

Water hemlock² frequently grows along ditches on land that is pastured during a part of the year. In such places it is profitable to dig out or pull out the roots, which should then be destroyed.

In the case of some plants digging out would be impracticable. The death camas,³ for instance, grows from a bulb and in such enormous numbers that the cost of digging would be greater than the value of the range. The same thing is probably true of lupine and sneezeweed.⁴

¹ *Oxytropis lamberti*.

² *Cicuta*.

³ *Zygadenus venenosus*.

⁴ *Dugaldia hoopesii*.

In a general way, then, it may be stated that eradication is distinctly profitable in some locations, but it is necessary to study the local conditions of each range and use common sense in planning any attempt to actually destroy the poisonous plants.

USE OF THE RANGE WHEN PLANTS ARE LEAST POISONOUS.

Some plants are much more dangerous at certain times of the year. The common death camas is a spring plant which dries up after blossoming and disappears. Most of the cases of poisoning of sheep by this plant occur in May and June. It is evident that special care should be used in handling sheep in death-camas areas at the time when poisoning may occur. Unfortunately many sheepmen and herders can not identify this plant, and it is of first importance that they should learn to recognize it, especially in its early stages before blossoming, for then it is frequently mistaken for one of the grasses.

The lupines are a source of greatest harm at the time when the pods are full of seeds, for it is the seeds that are especially poisonous. Most of the cases of lupine poisoning occur in the late summer and fall. During especially dry seasons a large part of the lupine seeds may fail to mature, and during such seasons the losses from lupine are apt to be less than after a wet summer. The lupines, then, should be especially avoided in the late summer and fall.

The low larkspurs are spring plants and except at great elevations have largely disappeared by July 1. If cattle can be kept from a range heavily covered with low larkspur until about July 1 there is little danger of loss. This has been clearly recognized in some localities, and the cattle are kept down by an organized body of riders. The tall larkspurs blossom later and do not die down until killed by fall frosts. After blossoming, however, they gradually lose their poisonous properties in all parts of the plant except the seed and cattle seldom eat much of the seed. If the cattle can be kept away until after the tall larkspur has blossomed they can be turned in, and although they then frequently eat the larkspur plants greedily, no harm results. Generally speaking, on the Colorado ranges, the danger period for all larkspurs is over by the middle of July. No definite date can be given, however, for the time when a range is safe, because the time of blossoming may vary because of climatic conditions. On some of the California ranges the larkspur may continue blossoming as late as September, so that there may be cases of poisoning in the fall. Only by actual inspection can one be sure that a range is safe. On some ranges drift fences have been constructed to keep the cattle from the higher ranges which are infested with high larkspur. These drift fences have not in all cases accomplished as much as they should. In some localities the fences keep the cattle down through the whole season, thus permitting much valuable range to remain unused.

Sometimes cattle are admitted through the drift fence at a time when the larkspur is still poisonous, and disastrous results have followed. Generally speaking, the higher ranges are safe in the late summer and fall, but it must be remembered that in a wet or backward season the tall larkspur may be late in blossoming and thus will remain poisonous for a longer period. If by actual inspection it is found that most of the plants have passed the blossoming period, there is very little risk in admitting the cattle to a larkspur-covered range, and thus some of the best forage of the summer may be utilized to good advantage.

ALLOTMENT OF RANGE TO ANIMALS NOT AFFECTED BY POISON.

The loco plants affect all grazing animals, but some plants are poisonous to one class of animals and not to others. Cattle and horses rarely suffer much from death camas, so that they might be grazed where sheep would probably be poisoned. The lupines are much more dangerous for sheep than for cattle and horses. The larkspurs, while deadly for cattle, do not poison horses or sheep. Horses can be affected by larkspur, but as a matter of fact never eat enough under range conditions to harm them. Sheep, on the other hand, not only are not injured by larkspur, but seem to find it a good forage plant. It is evident, then, that a range covered with larkspur can be used for horses or sheep in some cases, and, where it is practicable to make such allotments, it is the simplest way of solving the larkspur problem.

While the investigation work on the sneezeweed of the western ranges is incomplete, enough is now known to show that it is harmful to sheep, but apparently not, under range conditions, to cattle or horses. It might be possible, then, to use safely a sneezeweed range for cattle or horses, while it would be dangerous for sheep.

This method of allotting ranges to animals that can graze upon them with impunity, rather than to attempt to make such changes in the ranges themselves as to adapt them to particular classes of animals, would seem to be the simplest and most natural way of handling the poisonous-plant problem. It is taking the line of least resistance: in other words, using natural resources in the easiest way rather than in a laborious way endeavoring to change natural conditions to suit our own ideas. The method has already been used to a limited extent, but it is susceptible of much wider application.

ABUNDANCE OF OTHER FEED PREVENTS EATING OF POISONOUS PLANTS.

Farmers' Bulletin 536, entitled "Stock Poisoning Due to Scarcity of Food," published in 1913, emphasized the relation between scarcity of food and losses by poisonous plants. This relation can not be

brought too forcibly to the attention of stockmen. Most poisonous plants are unpalatable, and are only eaten under stress of necessity. There are, of course, exceptions to this, for some animals acquire a real passion for certain harmful plants; this is especially true in regard to the loco plants. Generally speaking, however, the poisonous plants are avoided in the presence of good forage; even in the case of the locoes most locoed animals acquire the habit during the seasons when the grass is dry or scarce and the loco is the easiest plant to get. Careful stockmen who see that their animals have an abundance to eat during the seasons when loco is most attractive suffer few losses from this cause. Most of the cases of water-hemlock poisoning occur when there is such a shortage of feed that even roots are eaten.

The heavy losses of sheep from death camas and lupine ordinarily occur when hungry sheep are driven upon an area covered with these plants. This frequently occurs when sheep are turned directly from the cars into a pasture or upon a range where these plants are growing; under such circumstances the sheep fill up on the first plants reached. Some of the heaviest losses of individual owners have happened this way; a striking example of this being a loss of 900 out of a band of 2,000 in Washington in 1915. If the owner in such a case had purchased feed and made sure that the sheep were well filled before being turned out, the animals might have been saved. The losses from some plants like cherry and milkweed almost always occur under stress of a scarcity of good forage. To a less extent it is true of poisoning by the various species of laurels,¹ some of which are found in the mountains of the East as well as in those of the West.

CARE IN DRIVING STOCK AND IN BEDDING SHEEP.

If sheep are bedded for several nights in the same place they will, in going back and forth, eat everything near the bedding ground. Naturally they take the best feed at first, but later they will eat the poisonous plants if they are present. It is not unusual for sheep to be poisoned in this manner after being on a bedding ground for two or three days. So far as poisonous plants are concerned, it is much safer to take a new bedding ground, if possible, every night. The Forest Service is advocating strongly the "open herding" or "blanket herding" or "bedding out" method, both for the sake of the welfare of the sheep and the preservation of the range. This system would avoid much of the loss from poisonous plants, for if the sheep are allowed to graze leisurely and proceed gradually over a range, not retracing their steps but bedding down in the place

¹ Species of *Kalmia*, *Rhododendron*, *Azalea*, *Lencothoe*, *Ledum*, and *Menziesia*.

where they arrive at night, they will select their food with more care and be less likely to eat any injurious plants, as they do not eat these plants by choice. On the other hand, when hungry sheep are being driven they snatch eagerly at any kind of vegetation and do not exercise any selective care in the plants eaten.

The same principle applies to driving cattle through a larkspur region. If cattle are moved from place to place, and it is known that they are to pass through larkspur, care should be taken to have them well fed before making the drive. Hungry cattle will snatch eagerly at whatever can be reached, and tall larkspur is especially tempting under such circumstances. Urged by both hunger and jealousy of each other they will eat all they can reach. It is evident, too, that it is best not to hurry animals on a drive. They should, if possible, be drifted, not driven. When drifted they will spread out and select their food with more care. Many cattle are lost from larkspur and many sheep from death camas and lupine because they are hurried, in compact masses, over a poison area, when they might pass over this area safely if, after feeding, they were drifted across.

CARE IN HANDLING ANIMALS NEW TO A RANGE.

Special care should be exercised when animals are brought in from another region and turned out upon a range to which they are not accustomed. This is well known to most stockmen, but too frequently they do not take the precautions which their own experience tells them are necessary.

ELIMINATION OF FIXED DRIVEWAYS.

In many places cattle and sheep are driven from one range to another over fixed driveways. These driveways in some cases are little more than lanes. Even where there are no fences the driveways are sometimes very narrow. On some ranges used for both cattle and sheep the trails over which the sheep may be moved are definitely marked out and have very narrow limits. These driveways are frequently grazed so completely that no vegetation is left. It is evident enough that sheep coming off a bare driveway will be very hungry and ready to eat everything in their way, sometimes with bad results.

It is not at all unusual for animals to be poisoned on a driveway. In such cases it is frequently stated that while some bunches go over the area with no loss, others are poisoned. This apparently may be explained in this way: The first bunches going over eat the most desirable forage; their successors for lack of other food may eat the injurious plants, until they too are all consumed. After that those following are not poisoned, for there is nothing for them to

eat. This is illustrated on driveways where there is much wild cherry. As a rule the first bunch of sheep will go over such a trail with no harm. Succeeding bunches will graze on the cherry, with resulting illness; but when all the cherry leaves within the reach of the sheep have been eaten, other bunches may go over the same ground with no cases of poisoning.

When a driveway is known to have poisonous plants—and this can as a rule be determined—it should, if possible, be abandoned in favor of one that is safe. It is better to do this, even if the new driveway is somewhat inconvenient. It is still better to do away with definite restricted driveways wherever this is possible. In many places, of course, this can not be done, for the topography is such that the only way of getting from one locality to another is by a narrow driveway, but there are other places on the range where the driveways in use at the present time might be abandoned.

In regions where both cattle and sheep are grazed and it is necessary to restrict each class to a definite location, care should be taken that, so far as possible, successive bunches should not be moved over the same part of a range. Anything approaching a definite driveway should be avoided whenever it can be done.

Generally speaking, both cattle and sheep should be driven as little as possible. Whenever they are moved from one place to another they should be drifted if the conditions will permit. In this way not only will the losses from poisonous plants be lessened, but both the animals and the range will be kept in a better condition.

ROTATION IN USE OF RANGE.

It has already been shown that inasmuch as some of the poisonous plants do not affect certain classes of animals, many losses may be prevented by apportioning the ranges in such a way as to place upon them such animals as will not be harmed by the vegetation on them. This principle has been recognized in the administration of the national forests by the restriction of certain larkspur ranges to the use of horses and sheep. Thus far the general tendency in this apportionment of ranges has been to make certain regions definitely and for an unlimited time sheep ranges or horse ranges. Now it is a well-known fact that the different classes of range animals do not eat the same forage plants. This is especially evident when sheep are compared with cattle and horses. Sheep do not care especially for the grasses, but prefer certain weeds, and if these weeds are present in sufficient abundance the sheep will leave the grasses. A range used exclusively by sheep presents a very different appearance from one used by cattle because of the difference in the plants which remain after grazing. This is no new discovery, but is well known to all who are familiar with range conditions. It follows that

a range depleted by the grazing of one class of animals may be improved by changing to another. In other words, wise "rotation" may greatly benefit the range and at the same time assist in solving the poison-plant problem. Such rotation, however, can be successful only when it is planned out carefully after a thorough knowledge of the local conditions of the range has been obtained, based upon an intimate acquaintance of as long a time as possible. A botanical examination in a single year would not accomplish this, for it could not take into account meteorological and other conditions which might seriously modify the character of the plants on the range.

Such a rotation of grazing herds probably, too, could not be carried out under any fixed plan which would involve definite periods during which the range should be used by any class of animals. The range must be under careful observation and such changes made as are indicated by the condition of the vegetation. Any plan must be more or less experimental and subject to such changes as the needs of the range suggest. No general plan should be adopted, but the individual ranges should be thoroughly studied by local officers and such changes made from time to time as are necessary. A difficulty would doubtless be experienced from the fact that animals become accustomed to a range, and are more easily handled when they are kept on the same range from year to year. The benefits of rotation, however, might counterbalance any trouble from this source.

The rights of the permittees, too, must be recognized and rotation changes should be so made as not to work hardship upon the men using the range. Rotation should not be a universal practice, but should be adapted to the needs of the individual range. If used wisely it would seem possible not only to reduce the losses from poisonous plants, but materially to improve the range.

SUMMARY.

1. Most losses of live stock by poisonous plants are, primarily, more or less closely connected with a lack of suitable forage.
2. While something may be accomplished by the application of medical remedies to the sick animals, the main reliance in reducing losses must be upon careful management of the range and the animals upon it.
3. This management should be directed to the destruction of the poisonous plants in some cases; the use of the range when the plants are not poisonous in other cases; the allotment of some ranges to animals not affected by the plants; care in driving live stock and in bedding places for sheep; the elimination of fixed driveways; and to "rotation" in the use of the range.

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UNITED STATES DEPARTMENT OF AGRICULTURE



FARMERS' BULLETIN



WASHINGTON, D. C.

721

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Contribution from the Bureau of Entomology, L. O. Howard, Chief.

THE ROSE-CHAFER.¹ A DESTRUCTIVE GARDEN AND VINEYARD PEST.

By F. H. CHITTENDEN, *In Charge of Truck-Crop and Stored-Product Insect Investigations*, and A. L. QUAINANCE, *In Charge of Deciduous Fruit Insect Investigations*.

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INTRODUCTORY.

About the time of the blossoming of grapes, roses, and many garden flowers a long-legged beetle of a light ochre or yellowish-brown color, called the rose-chaffer or "rose-bug," makes its appearance in certain sections of the country and strips bushes and vines of blossoms and foliage. This beetle is about one-third of an inch in length and may be recognized by comparison with the accompanying illustration (fig. 1, *a*).

These insects appear suddenly and in vast swarms in certain years, usually toward the middle of June in the Northern States and about two weeks earlier in their southern range, and overrun the garden, vineyard, orchard, and nursery. In about a month or six weeks from the time of their first arrival, generally after they have done a vast amount of damage, the beetles disappear as suddenly as they came.

DISTRIBUTION.

The rose-chaffer occurs in the North, from Canada and Maine southward to Virginia and Tennessee, and westward to Oklahoma and Colorado. It is particularly injurious in Massachusetts, Rhode

¹ *Macrodactylus subspinosus* Fab.; order Coleoptera, family Scarabæidae.

Island, New Jersey, Delaware, and Ohio, and has been reported as very destructive in portions of New York, Pennsylvania, Maryland, Virginia, West Virginia, Illinois, Indiana, Kansas, Nebraska, southern Michigan, and Vermont, but is not destructive in all portions of these States. Light sandy regions are greatly preferred by the insects as breeding grounds, and clay lands, unless near sandy soil, are seldom troubled with them.

FOOD PLANTS AND INJURY.

For some time after the rose-chaffer was first noticed it confined its ravages to the blossoms of the rose. There is a record, however, of its having been destructive to grapes as early as 1810. In later years it has extended its range of food plants until now it is nearly

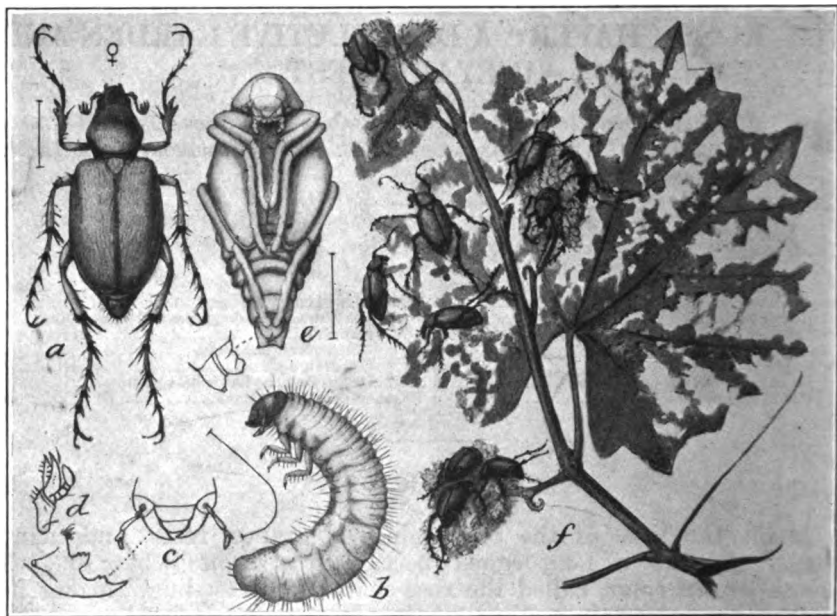


FIG. 1.—The rose-chaffer (*Macrodactylus subspinosus*): a, Adult or beetle; b, larva; c, d, mouthparts of larva; e, pupa; f, injury to leaves and blossoms of grape, with beetles at work. a, b, c, Much enlarged; c, d, more enlarged; f, slightly reduced. (From Marlatt.)

omnivorous. The rose and grapevine especially suffer from its depredations, but it is almost equally destructive to fruit, shade, and other trees and shrubs. In times of great abundance these insects completely destroy flowers and other ornamental plants of many sorts, even attacking berries, peas, beans, and nearly all garden fruits and vegetables, corn, wheat, and grasses. Almost every form of vegetation is devoured.

The beetles do not confine their ravages to any particular portion of a plant, but consume alike blossoms, leaves, and fruit.

In their attack upon the grape they first devour the blossoms, then the leaves, which they completely strip, leaving only a thin network. and later the young berries are eaten (figs. 2 and 3). Whole vine-

yards and orchards are often devastated, and the fruit crop of certain sections of country destroyed. It is no uncommon sight to see every young apple on a tree completely covered and obscured from view by a sprawling, struggling mass of beetles. (See fig. 4.)

Since the late eighties the rose-chaffer has been particularly injurious in grape-growing regions and has been the subject of research and experiment at the New Jersey Agricultural Experiment Station and by the Bureau of Entomology in the Lake Erie region of Pennsylvania.¹

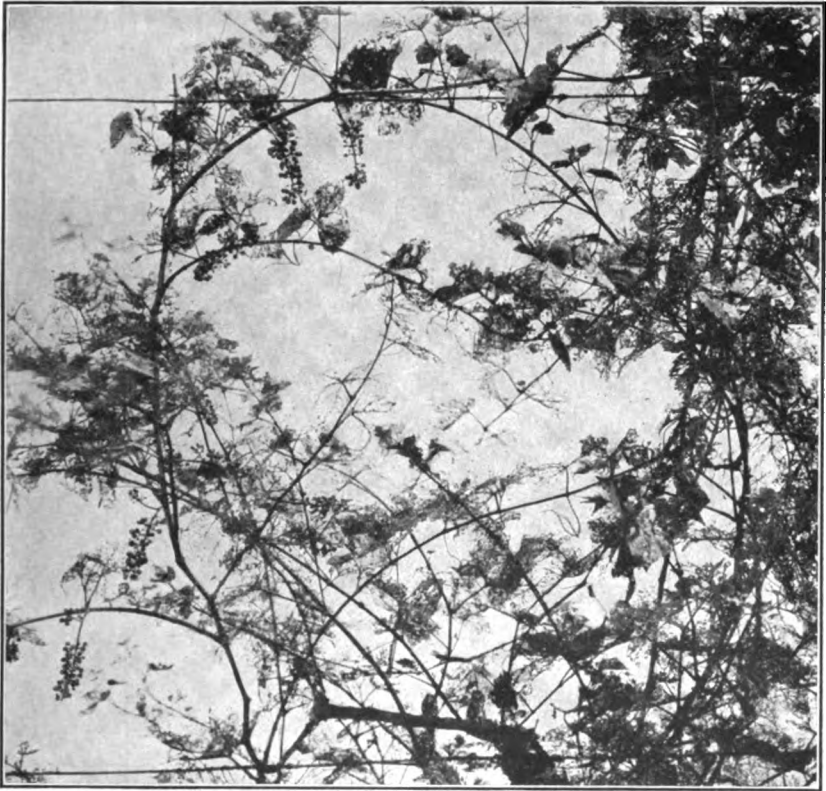


FIG. 2.—Grape foliage showing injury by rose-chaffer. (Original.)

ROSE-CHAFER POISONOUS TO CHICKENS.

It has frequently been stated that the rose-chaffer is injurious to small chickens, and it was the general belief that their death was due to mechanical injury or puncturing of the lining of the digestive tract by the spines on the legs of the beetles that had been swallowed. In other cases it was stated that the rose-chaffer had eaten into the crops of the chicks. Cases have been reported recently of hundreds of chickens being killed in this manner. Death usually occurred in from 9 to 24 hours after feeding. Some experiments have been performed to determine the cause of the injury, and it was proved that

¹ Johnson, Fred. Vineyard spraying experiments against the rose-chaffer in the Lake Erie Valley. U. S. Dept. Agr. Bur. Ent. Bul. 97, pt. 3, p. 53-64, pl. 4-7, fig. 10-21. 1911.

15 to 20 rose-chafers were sufficient to cause the death of a chick 1 week old. In the case of a 10-week-old chicken, 96 undigested rose-chafers were counted in a post-mortem examination. An extract made from 40 grams of rose-chafers was injected into rabbits, which died in six minutes, and in one case in three and one-fourth minutes after the injection of 4 c. c. Other rabbits were killed in proportion

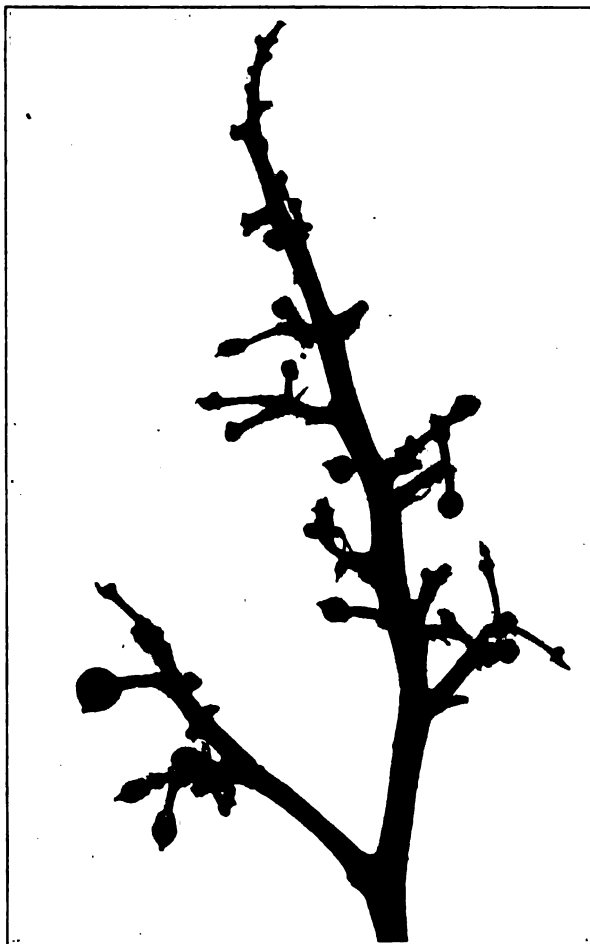


FIG. 3.—Grape cluster showing almost total destruction of young berries through feeding of rose-chaffer. (From Johnson.)

to the size and dose. The opinion was reached that owing to the fact that the insect feeds on a large number of plants, and especially on daisies, its body contains a neuro-toxin which affects the hearts of small animals, such as chickens and rabbits.¹

NATURAL HISTORY AND HABITS.

The rose-chaffer, as already stated, appears early in June, the date varying somewhat according to locality and season. Soon after

¹ Lamson, G. H. The poisonous effects of the rose-chaffer upon chickens. *In Science*, v. 43, no. 1100, p. 138-139. Jan. 28, 1916.

emerging from the ground it mates and begins feeding. For from four to six weeks after their appearance the beetles continue feeding, almost constantly paired. The female deposits her eggs singly, from 24 to 36 in number, a few inches beneath the surface of the earth, where in from two to three weeks they hatch and the young larvæ or grubs begin feeding on such tender rootlets, preferably of grass, as are in reach. By autumn the larvæ, which are yellowish white in color, with pale-brown heads, have reached full growth and present the appearance shown in figure 1 at *b*. Late in autumn they descend

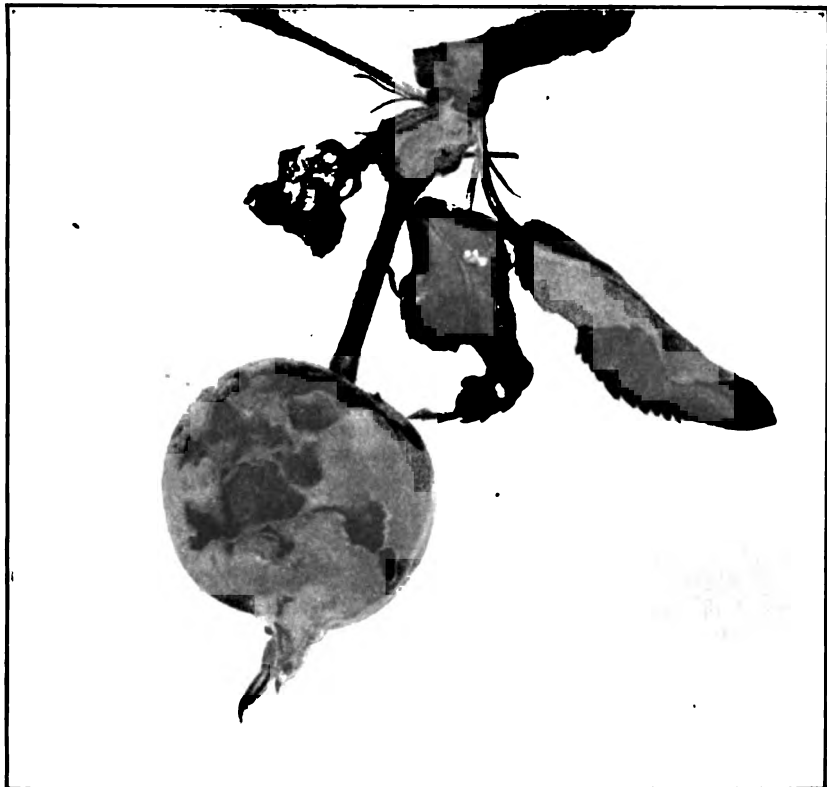


FIG. 4.—Young apple showing injury by rose-chaffer. (Original.)

lower into the earth, below the frost line, each grub forming a little earthen cell in which it passes the winter. In April or early in May they transform to pupæ, and in from two to four weeks afterwards the beetles emerge, dig their way out of the ground, and renew their destructive work. A single generation of the species is produced in a year, and about three weeks is the average duration of life for an individual adult.

METHODS OF CONTROL.

The rose-chaffer is one of our most difficult insect enemies to combat successfully. Almost every appropriate method that has ever been employed against other insects has been tried against this one, and much has been written on this insect, but a thoroughly effective remedy is yet to be discovered when the insects appear in excessive

numbers. Every year or two "new and successful remedies" are suggested, but when tested on a large scale in badly infested vineyards or orchards, these are found unsatisfactory.

The greatest difficulty encountered is that any application that may be made is unsuccessful unless applied almost continuously. Poisons that will kill the beetle are not satisfactory when the insects are abundant, because of their comparatively slow action. The blossoms have already been entirely destroyed before the poisons have taken effect, and the dead beetles are constantly being replaced by others that come from the ground or fly from neighboring places. Every beetle on a plant may be destroyed one day, but on the day following the plant will again be completely covered by them. Moreover, it is difficult to spray an entire garden so that every bud and blossom will be coated with the poison.

PRACTICALLY USELESS APPLICATIONS.

The various compounds of copper, lime, kerosene, and pyrethrum, hot water, and other so-called sure remedies have failed to give the desired results when subjected to a rigid test. Some substances, pyrethrum, for example, will stupefy the beetles for a short time, but they soon recover and resume feeding.

Hot water is not effective because of the practical impossibility of applying it in a spray or jet at a sufficiently high temperature to kill the insects and not destroy the fruit and flowers.

Decoctions of tobacco and quassia, as well as solutions of hellebore, alum, and a number of proprietary remedies that have been tried, apparently have no deadly effect on the rose-chaffer.

USE OF ARSENICALS ON ROSES.

Paris green has not proved a success against this species, for, while it will not discolor the leaves badly, it will damage the flowers. Furthermore, repeated applications are necessary. When Paris green is added to Bordeaux mixture the combination produces bluish discolorations and seems to have little, if any, effect as a repellent. Arsenate of lead has been tried and found to be more destructive than other arsenicals, acting both as a repellent and a poison, but it works more slowly. It also has the disadvantage, in the case of ornamentals, of leaving a whitish deposit. Arsenite of zinc leaves a still thicker and a more permanent white deposit, and if fish-oil or similar soap is used as the "sticker," or adhesive, this latter substance leaves an unpleasant odor.

It is obvious, therefore, that we can not depend upon any of the arsenical group as preventives of injury by the rose-chaffer to roses and other bright-flowering plants, although on some other plants they might be used successfully. Knowing these facts, it is not at all likely that the average rose grower could be induced to use any of the arsenicals.

It is possible that a heavy application of arsenate of lead, say 5 pounds to 50 gallons of either water or Bordeaux mixture, will largely protect ornamental plants that are hardy, and this plan should be tested by those who are confronted with this pest. Very thorough applications should be made on the first signs of the insects' presence and repeated as found necessary.

USE OF ARSENICALS ON GRAPES AND OTHER FRUITS.

Experiments made by the Bureau of Entomology in the grape belt of the Lake Erie Valley during 1910-11 indicate that a considerable degree of protection of vineyards from rose-chaffer injury may be obtained by timely and thorough use of arsenical sprays, the amount of benefit varying with the abundance of the insects. Since the use of poison sprays at the time of rose-chaffer invasion is desirable for the control of other grape pests, such as the grape berry moth, grape flea-beetle, etc., vineyards in sandy regions and subject to rose-chaffer attack should be sprayed regularly for this insect as a part of the routine of vineyard work.

In the Bureau's experiments arsenate of lead has been used at the rate of 5 pounds to each 50 gallons of liquid. The poison preferably should be used in Bordeaux mixture, the application of which is essential for the control of fungous diseases. It is a prevalent belief that the addition to the poison spray of molasses or glucose renders it attractive to the beetles and insures better results. Observations and experiments on this question, while not conclusive, throw doubt on the value of the recommendation.

The first application of spray should be given just before the blossoms open, and if the beetles continue destructive the treatment should be repeated as soon as the blossoms have fallen. Arsenate of lead (paste) should be used at the rate of 4 or 5 pounds to 50 gallons of water or Bordeaux mixture, and the spray should be applied very thoroughly. Vineyardists should adopt a definite spraying schedule,¹ which will insure the maximum protection from the various insects and fungous diseases of the vine. Vineyards regularly sprayed should be less injured by the rose-chaffer than those not so treated.

For the destruction of the beetles on fruit trees, as peach, apple, etc., arsenate of lead should be used, preferably in a fungicide, such as Bordeaux mixture, when the beetles first appear. It should be applied at the same strength indicated for vineyards, namely, 4 or 5 pounds to 50 gallons of spray. In spraying peaches and other stone fruits the arsenical should be used in the self-boiled lime-sulphur wash² or in water to which has been added lime wash made from slaking 3 or 4 pounds of good stone lime. Repeated applications may be necessary, depending upon the extent of reinfestation of the trees by newly emerged beetles, or those from other sources.

HAND PICKING.

The old-fashioned remedy of hand picking is of service when the beetles infest rose bushes, grapes, or other low-growing plants. The beetles may also be jarred from trees and bushes over sheets saturated with kerosene, but these methods are tedious and must be practiced daily in the early morning or toward sundown to be effective. A number of useful mechanical appliances formed on the plan of a funnel or inverted umbrella, with a bag or can containing kerosene at the bottom, have been devised for the collection of the beetles as they are jarred from the plants.

NETTING AND BAGGING.

Choice plants may be securely protected by a covering of netting, and when the process of bagging may profitably be employed, this method should be followed. Bagging, as is well known, prevents

¹ See Farmers' Bulletin 284, U. S. Department of Agriculture.

² See Farmers' Bulletin 440, U. S. Department of Agriculture.

fungus, bacterial infection, and, in addition, flowers so protected are of superior appearance and quality. Bagging of grape clusters for protection against the rose-chaffer is often practiced and affords protection against other insect pests as well.

USE OF LURE PLANTS.

Small gardens may be protected, at least from the first arriving horde of the chafers, by planting about them early-flowering plants that particularly attract the beetles. Spiræas, deutzias, andromeda, magnolias, blackberries, and white roses are especially useful as counter attractives. The beetles swarm on the flowers of these plants in preference to other flowers and small fruits, and when thus massed in great numbers their destruction by the use of collectors or other mechanical means is greatly facilitated.

DESTROYING THE LARVÆ AND PUPÆ.

In addition to the use of any of the methods described above, injury in gardens may be appreciably lessened by preventing the breeding of the insects within or in the immediate vicinity of the garden.

According to experiments conducted in Ohio during the years 1893-94,¹ the rose-chaffer may be destroyed by taking advantage of the delicate nature of the pupæ. This insect while in the pupal stage is so extremely sensitive to disturbance that, even with the greatest care, specimens were not successfully transferred to the laboratory for rearing, and all specimens disturbed in their pupal cells perished. Since both larvæ and beetles are very tenacious of life, the pupal stage appears to furnish the most vulnerable period of attack, and large numbers of the pupæ may be destroyed by stirring the breeding grounds, at the appropriate time, to a depth of 3 or more inches. In the latitude of northern Ohio the most favorable time for the application of this remedy is from about May 25 to June 10. In more southern latitudes operations should be commenced earlier.

All ground which might serve as a breeding place and which it is possible so to treat should be plowed and harrowed at the proper time in the spring. The least possible area of light sandy soil should be left in sod, only the heaviest land being used for grass.

GENERAL CONSIDERATIONS.

Whatever practice of a remedial nature is undertaken, whether collecting or spraying, should be begun at the first onset of the insects' attack and continued until their disappearance. Nor should work be confined entirely to those useful plants the preservation of which is desired. Many weeds and wild plants, notably the ox-eye daisy and sumac, are special favorites of this species, and when practicable the beetles should be destroyed on them to prevent their spreading to cultivated land.

If persistent and combined effort on the part of fruit growers and truck growers of limited regions subject to infestation were made against this insect, its numbers might in a few seasons be so diminished that practical immunity from injury would be secured for several years.

¹ Webster, F. M. The rose chaffer or rose bug: how to deal with it. In 27th Ann. Rept. Ohio State Hort. Soc. f. 1893-94, p. 87-91. 1894.

UNITED STATES DEPARTMENT OF AGRICULTURE



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722

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Contribution from the Bureau of Entomology, L. O. Howard, Chief.

THE LEAF BLISTER MITE OF PEAR AND APPLE.¹

By A. L. QUAINANCE,

In Charge of Deciduous Fruit Insect Investigations.

INTRODUCTION.

Leaf blister mites are among the smallest of animal forms which attack horticultural crops. These minute creatures, only one one-

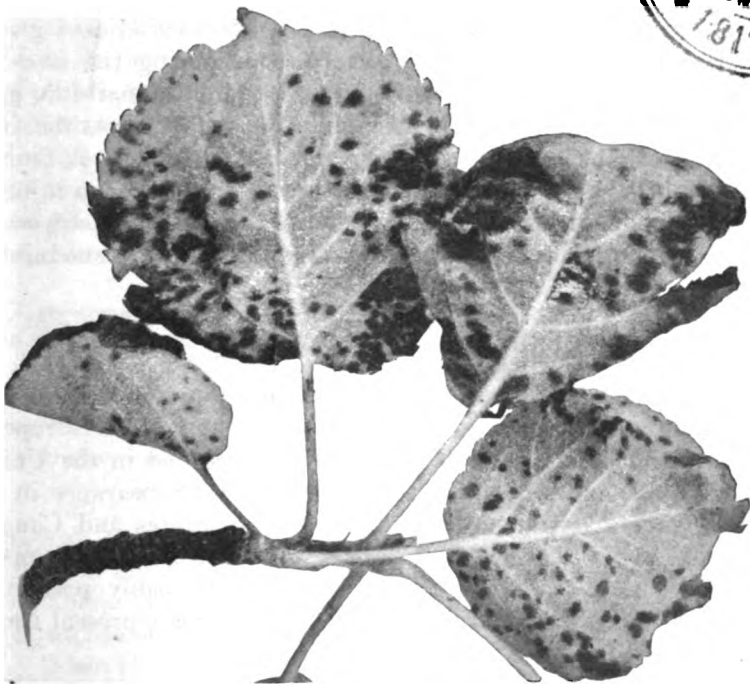
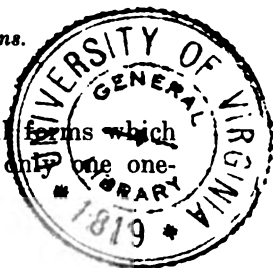


FIG. 1.—Apple leaves injured by the leaf blister mite. (Original.)

hundred-and-fiftieth of an inch in length, are invisible to the unaided eye, and as seen under a good hand lens appear as the merest

¹ *Eriophyes pyri* Pagenstecher; order Acarina, family Eriophyidae.

speck. Although the mites themselves are probably unfamiliar to most orchardists, their work is well known to pear growers and apple growers in the reddish or greenish pimples or blisterlike spots to be noted in early spring on the young foliage of these plants. Later these blisters become brown and dead, spotting and blotching the leaves, the injury resembling that due to leaf-spot fungi or from sprays, with which injury, in fact, the work of this mite is frequently confused. When the creatures are abundant the foliage may be almost covered with the blisters or brown spots, and the usefulness of the leaves to the tree is thus greatly impaired. Foliage severely injured will fall prematurely, retarding the development of the fruit, and in extreme cases much of the crop will fall to the ground. (See fig. 1.)

The leaf blister mite is not an insect but belongs to that class of animals containing the spiders, scorpions, daddy-long-legs, etc., and to the order represented by such well-known forms as the scab mite of sheep, the cattle tick, and the red spider. Its family contains numerous species, all of which are plant feeders, attacking principally the buds and leaves. Several members of the family are of much economic importance. One¹ infests vinifera varieties of grapes in portions of Europe and in California, producing the so-called "erinoe" of the vine. Another² is the cause of the nail-like galls sometimes found on the leaves of plum. A third³ infests the fruit and foliage of the orange, producing a russeted condition. A fourth⁴ feeds upon the upper surface of the leaves of the peach, so injuring them as to give the foliage a silvery sheen. Still another⁵ occurs on the foliage of the apple, and in Montana very important injuries have been attributed to it.

ORIGIN AND DISTRIBUTION.

The leaf blister mite is not native to the United States and was probably introduced at an early period, presumably from Europe on nursery stock, buds, or scions. It was first recorded in the United States in 1872, and since that date has made its appearance in the principal pear-growing regions of the United States and Canada. It is known to occur in England, Russia, and certain other European countries, is recorded from Tasmania, and is probably present in other fruit-growing regions of the world, being at the present time a truly cosmopolitan pest.

¹ *Eriophyes vitis* Landols.

² *Eriophyes pad* Nalepa (= *E. pruni-crumena* Walsh).

³ (*Typhlodromus*) *Phyllocoptes oleivorus* Ashmead.

⁴ *Phyllocoptes cornutus* Banks.

⁵ *Phyllocoptes schlechtendali* Nalepa.

CHARACTER OF INJURY AND DESTRUCTIVENESS.

The mites pass the winter on the trees, under the bud scales, and attack the leaves as soon as these begin to push out in the spring. They bore small holes from the underside to the interior of the leaf, where they deposit their eggs, and with their progeny feed upon the tender cells of the leaf substance. Their activities within the leaf tissues very quickly result in the development of galls or swellings. These are at first small, pimple-like eruptions, especially evident on the upper surface of young leaves, whitish in color on the apple, but usually with a reddish tinge on the pear. The spots soon increase in size, the largest becoming as much as one-eighth of an inch in diameter. On pear leaves the spots, as a rule, become red, often brilliantly colored as they grow, whereas on apple this reddish coloring is absent or faint. On the underside of the leaf the



FIG. 2.—Pear leaf gall, in cross section, of leaf blister mite: o, Opening of gall; e, eggs of mite; n, normal structure of leaf. (After Sorauer.)

galls are whitish and blisterlike, not differing much from the general color of the leaf surface. Later they turn brownish or black, due to the death of the injured leaf cells, lose much of their thickness, and some may become somewhat shrunken. Figure 2 illustrates a gall on pear leaf as seen in cross section, the normal structure being shown at *n*; *o* is the opening to the interior of the gall and *e* designates eggs of the mite. A cross section of one of the dried-up galls is shown in figure 3.

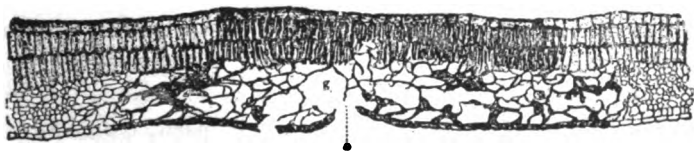


FIG. 3.—Section of pear leaf, showing structure of gall of blister mite in autumn; g, Gall; o, opening of gall. (After Comstock.)

On pear, the galls occur more along each side of the midrib of the leaf and on apple at the base of and along the margins of the leaf. When numerous, however, the spots will merge together, forming large patches or bands of variable size, often involving most of the leaf. When thus abundant the leaves may become more or less ruptured and wrinkled, and in the case of the apple the margins may curl up, showing the underside. Leaves badly infested are likely to fall prematurely, resulting also in the dropping of the fruit from clusters with worst injured foliage. The fruit and fruit-stems of

both apple and pear are also attacked, the light-colored pimples occurring mostly around the calyx end of the fruit and resulting in no material injury. The injury to the fruit-stems is noticeable as irregular thickenings, and when severe may cause some of the fruit to fall, although loss from this source, even in worst infested orchards, will not be great.

FOOD PLANTS.

Pear and apple are the more common food plants of the blister mite, though other plants are attacked. The mite has been recorded from foliage on the white beam tree,¹ the European mountain ash,² the wild service tree,³ the service berry,⁴ and the common cotoneaster.⁵

According to one entomologist the mites have been found on over 250 varieties of apples, injury being severe on some well-known commercial sorts, as Ben Davis, King, Baldwin, Rhode Island Greening, and at the agricultural experiment station at Geneva, N. Y., the Williams Favorite was noted to be especially subject to attack, the trees having been prematurely defoliated for two successive seasons.

DESCRIPTION AND HABITS.

The general appearance of the blister mite is shown in figure 4 in dorsal and ventral views. The mite is microscopic in size, measuring on the average about one one-hundred-and-fiftieth inch in length, whitish in color, a few individuals pinkish. The abdomen slopes gradually toward the posterior end and is numerously ringed. There are only two pairs of legs, and these and the body bear setæ which, from their character and location, are of importance in the determination of species in this group, as are also the number and character of rings on the abdomen. The young, except in size, bear a general likeness to the adults, and the eggs, though proportionately large as compared in size with the parent, are only 46 microns through the greater diameter. These are whitish, translucent, with rounded ends, and are deposited in the interior of the galls (see fig. 2). The resulting larvæ feed upon the cellular leaf substance, working out in various directions, though they are not especially active.

The mites are to be found on the foliage from their appearance in spring until fall, and several generations are evidently produced in a season. Hibernation occurs under the bud scales, the mites often congregating in colonies of 50 or more. They become active in the spring, often before the buds burst, congregating around the base of

¹ *Sorbus aria* Crantz. ² *Sorbus aucuparia* L. ³ *Sorbus torminalis* Crantz. ⁴ *Amelanchier vulgaris* Moench. ⁵ *Cotoneaster vulgaris* Lindl.

bud scales, where they feed, many molting at this time. With the bursting of the buds and the pushing out of the tender leaves, these are attacked and the characteristic blisterlike spots soon develop.

Notwithstanding the minute size of these creatures, they fall prey in considerable number to the attack of a mite (*Seius pomi* Parrott) which is thought to assist materially in reducing their numbers.

METHODS OF CONTROL.

The leaf blister mite will yield to thorough treatment with kerosene emulsion, miscible oils, or lime-sulphur washes. The use of

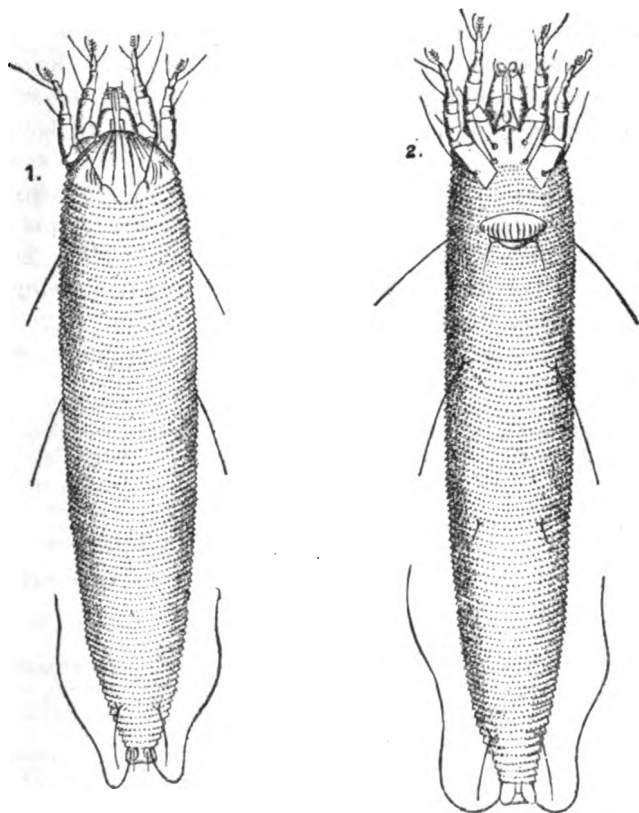


FIG. 4.—Leaf blister mite (*Eriophyes pyri*): 1. Dorsal view; 2. ventral view. Greatly enlarged. (After Nalepa.)

these sprays, as for the San Jose scale, should also protect orchards from important injury from the mites. When it is necessary to spray for the mites alone, and in cases of severe infestation, as has been noted in apple orchards in New York State, two treatments have been recommended by Parrott, standard kerosene emulsion being used, diluted with 5 parts of water. One application should be given in late fall as soon as most of the leaves have fallen and

another the following spring before the trees put out foliage. If both the fall and spring applications are not practicable, the preference should be given to fall treatment. At this time many of the mites have not yet gone to the bud scales, but occur in the pubescence of the young wood and hence are more easily killed.

Lime-sulphur washes¹ are excellent treatments for these mites and their employment is perhaps preferable as avoiding danger of injury to fruit buds by the oil sprays. If a lime-sulphur wash is employed, it should be applied with great thoroughness and the tree completely coated so that when spraying is finished it will appear as if white-washed.

On the pear the mites may be kept reduced to an important extent simply by searching out in the spring small branches bearing worst infested leaves, pruning these off and burning them, or sprays may be employed exactly as indicated for the apple, if this is considered necessary.

Except in cases of serious infestation special spraying for the blister mite will not be necessary. As to whether or not it is advisable to spray, the orchardists will have to decide after determining as exactly as is possible the amount of injury that is being done by the mites, and care should be taken not to confound with its injury that which has resulted from fungicidal or Paris-green sprays, and from leaf-spot diseases.

¹ Information concerning the preparation of lime-sulphur washes and kerosene emulsion will be found in Farmers' Bulletin 650, U. S. Department of Agriculture, pp. 16-25.

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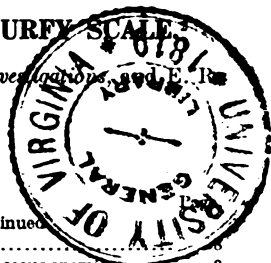
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APRIL 26, 1916

Contribution from the Bureau of Entomology, L. O. Howard, Chief.

THE OYSTER-SHELL SCALE¹ AND THE SCURFY SCALE²

By A. L. QUINTANCE, *In Charge of Deciduous Fruit Insect Investigations*, and E. J. SASSCER, *Collaborator*.



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INTRODUCTION.

The oyster-shell scale¹ and the scurfy scale² are, with the exception of the San Jose or Chinese scale,³ more frequently the subject of



FIG. 1.—Oyster-shell scale (*Lepidosaphes ulmi*) on poplar. Much enlarged. (Authors' illustration.)

inquiry by orchardists than all other species of scale insects combined. These two scale pests are now very generally distributed

¹ *Lepidosaphes ulmi* L.
28073°—Bull. 723—16

² *Chionaspis furfura* Fitch.

³ *Aspidiotus perniciosus* Comst.

throughout the country, and from their relatively conspicuous appearance are often detected by observant fruit growers who frequently believe them to be the more serious San Jose scale. The oyster-shell and scurfy scales, while not dangerous in the sense of generally causing the death of infested trees, are, however, of considerable economic importance. The complete killing of individual branches of apple trees by either species is a matter of frequent observation, and trees so badly infested are frequently greatly stunted and retarded in their growth, resulting perhaps in extreme cases in the death of the trees. Of the two species considered, the oyster-shell scale has been and is at the present time the more important. Its injuries to certain shade trees, especially poplar and maple, have been the cause of much complaint during recent years. Such shade trees are ordinarily not sprayed for scale insects, and the increase of these pests from year to year is thus checked only by their natural enemies. The writers have frequently seen maple and poplar trees literally incrustated from top to bottom with the oyster-shell scale, many of the limbs killed, and in rarer instances the trees quite dead, without doubt owing to the attack of this scale insect.

THE OYSTER-SHELL SCALE.

ORIGIN AND DISTRIBUTION.

The origin of the oyster-shell scale is a matter of some uncertainty. It has a world-wide distribution, and was introduced into the New England colonies at an early date. The first American account of this insect was written by Enoch Perley in 1794, and in it he stated that the pest was doing considerable damage to the apple in Cumberland County, Me. Shortly after 1860 it had reached the Mississippi River, and at the present time occurs in every State of the Union with the possible exception of South Dakota, Oklahoma, and Texas. Its occurrence in these States is practically certain, but there appear to be no records in literature to this effect, and it has not been received from these States by the Bureau of Entomology. The insect is very troublesome in the Northern States and is especially common in the New England States and those bordering the Great Lakes.

DESCRIPTION AND LIFE HISTORY.

This insect has received the common name "oyster-shell scale," owing to the resemblance of its scale, or covering, to a long narrow oyster shell, as may be seen by reference to figures 1 and 2. The adult female scales are about one-eighth of an inch in length, usually brown to dark brown in color, though occasionally they have a grayish appearance which is due to bleaching over winter. If present in large numbers, for want of room they assume various more or less

curved shapes. The scale of the male in shape and color resembles that of the female, but is smaller and possesses at the posterior extremity a small hinge or flap which permits the exit of the adult male.

If during winter or early spring one of the female scales be removed, numerous small, oval, white eggs varying in number from 40 to 100 will be revealed, and at the anterior portion can be seen the dead and shriveled body of the female.

In Canada and the Northern States there is thought to be but one full brood annually, whereas in the Middle and Southern States the species is double brooded.

The following records from literature and from the Bureau of Entomology will indicate the time in the spring of hatching of the eggs of this insect, in various localities. This time will of course vary with the season, but in general, as long ago stated by Dr. Mygatt in Illinois, will for any locality be shortly after the time of the falling of the blossoms of the apple.

Ontario: Eggs hatch about first week of June (Jarvis).

New York: Eggs hatch latter part of May to early June (Felt).

New Hampshire: Eggs hatch in late May to early June (Sanderson).

Vermont: Eggs hatch in late June (Stewart).

Maine: Eggs hatch about middle of June or later, depending upon the season (Hitchings).

Michigan: In specimens received June 18, 1909, from Stittsville, Mich., nearly all eggs had hatched (Sasscer).

Minnesota: In specimens received May 24, 1909, from Lamoille, Minn., eggs were hatching in numbers when received (Sasscer).

Indiana: In specimens received from Elwood, May 14, 1909, eggs were hatching in numbers when received (Sasscer).

Ohio: Eggs hatch in late May to early June (Gossard).

Second-brood eggs were found under many scales August 22, and a few young crawling at Cleveland (Quaintance).

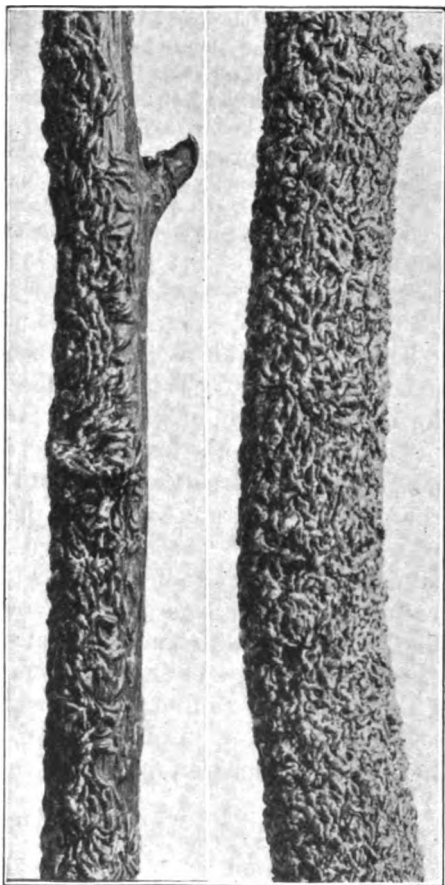


FIG. 2.—The oyster-shell scale (*Lepidosaphes ulmi*). Enlarged. (Authors' illustration.)

West Virginia: In specimens received April 30, 1908, from Parkersburg, W. Va., young were crawling in numbers (Sasscer).

Missouri (Wright County): Eggs hatch early in May. Insect double brooded according to a Mr. Wright (Riley).

Olden, Mo., eggs hatched March 29, 1907; apple trees bloomed March 24 (Girault).

Ozark region, Missouri, eggs hatch about April 25 to middle of May (Taylor).

Illinois (Cook County): Eggs hatch about June 6, females reach full growth by August 1, and oviposit August 12-28 (Riley).

District of Columbia: Eggs hatch May 5-14 (Quaintance).

July 4, eggs already deposited by most females and young crawling (Quaintance).

Maryland: Eggs hatch early in May (Symons).

Eggs of first brood hatch in May; eggs of second brood hatch in last week of July to first week of August (Johnson).

College Park, many recently settled scales in evidence May 21 (S. W. Foster).

Delaware: Eggs usually hatch in early May (Houghton).

New Jersey: Eggs hatch during early June (Smith).

Tennessee: In eastern Tennessee eggs hatch during first two weeks of April (Chambliss).

Eggs begin to hatch in April and those of the second brood along in July and August (Bentley).

This information as to the period of hatching of eggs in various parts of the country is of importance as bearing on the time to spray for the destruction of the young larvæ.

The female molts twice in the course of her growth, and in the adult condition is entirely without legs or eyes, being nothing more than a reproductive sack with her sucking mouth parts, through which the food is taken, inserted in the tissues of the plant. The adult male differs radically from the female in that it is provided with antennæ and one pair of wings, the second pair being present in the form of club-shaped organs known as balancers or halteres. During the process of change the mouth parts entirely disappear, and a second pair of rudimentary eyes assumes their place. Being without any means of taking in food, the male is naturally very short lived, its only mission appearing to be the fertilization of the female.

MEANS OF DISTRIBUTION.

Transportation by nursery stock, scions, or grafting or budding material is perhaps the only way this insect is carried from one section of the country to another, and this in a large measure accounts for its wide distribution. Locally it can be transferred from plant to plant only while in the young or crawling stage. The young are often seen crawling on other insects, such as beetles, or upon the feet of birds, and may in this way be carried some distance. Man and domestic animals may also assist in their dissemination, and it is possible that the winds blow them from plant to plant.

FOOD PLANTS.

The oyster-shell scale has a wide range of food plants, but is commonly found on apple, maple, horse-chestnut, poplar, willow, and lilac. The following is a list of the plants on which it is known to occur throughout the world:

- Alder (*Alnus rugosa* Spreng.).
 Almond (*Prunus* sp.), China.
 American aspen (*Populus tremuloides* Michx.).
 American bladdernut (*Staphylea trifolia* Linn.).
Amorpha sp.
Andromeda sp.
 Apple (*Malus sylvestris* Miller).
 Apple, crab (*Malus* sp.).
 Apricot (*Prunus armeniaca* Linn.).
 Arrow-wood (*Viburnum* spp.).
 Ash (*Fraxinus americana* Linn.), (*F. excelsior* Linn.), (*Fraxinus* spp.).
 Barberry (*Berberis* sp.).
 Balm of Gilead (*Populus balsamifera* Linn.).
 Basswood (*Tilia americana* Linn.), (*T. angustifolia*).
 Beech (*Fagus atropunicea* Sudw.).
 Bilberry (*Vaccinium myrtillus* Linn.).
 Birch, white (*Betula populifolia* Ait.).
 Birch, river (*Betula nigra* Linn.).
 Bittersweet (*Celastrus scandens* L.).
 Blackthorn (*Prunus spinosa* Linn.).
 Blueberry (*Oxycoccus* sp.).
 Box (*Buxus sempervirens* Linn.).
 Boxelder (*Acer negundo* Linn.).
 Broom (*Cytisus scoparius* Link.), Gurnsey.
 (*C. nubigenus* Link.), from Gurnsey(?).
 Buckeye (*Aesculus glabra* Wild.).
 Buckthorn (*Rhamnus cathartica* Linn.).
 Butternut (*Juglans cinerea* Linn.).
Calluna sp.
Camellia sp.
 Camphor tree (*Cinnamomum camphora* (L.) Nees & Eberm.).
 Cassia sp., in greenhouse.
 Cherry (*Prunus* sp.).
 Chestnut (*Castanea americana* Raf.).
Clematis paniculata Thunb.
 Cocoa palm (*Cocos nucifera* L.).
Cotoneaster sp.
 Cranberry (*Oxycoccus* sp.).
 Currant, black (*Ribes nigrum* Linn.).
 Currant, mountain (*Ribes alpinum*).
 Currant, red (*Ribes rubrum* Linn.).
- Dogwood (*Cornus alba* Linn.), (*C. alba* var. *sibirica* Lodd.), (?*C. alternata* Marsh.), (*C. californica* C. A. Mey.), (*C. sanguinea* Linn.).
 Elm, English (*Ulmus campestris* Smith).
 Elm, purple-leaved (*Ulmus scabra* var. *purpurea* Koch).
 ?*Euphorbia palustris* Linn., Germany.
 False bittersweet (*Celastrus scandens* Linn.).
 Fig (*Ficus carica* Linn.).
 Filbert (*Corylus* sp.).
 Ginseng (*Panax quinquefolium* Linn.).
 Gooseberry (*Ribes cynosbati* Linn.).
 Goatsbeard (*Aruncus sylvestris* Kost.).
 Grape (*Vitis vinifera* Linn.).
 Hackberry (*Celtis occidentalis* Linn.).
 Hawthorn (*Crataegus crus-galli* Linn.), (*C. oxyacantha* Linn.).
Helianthemum chamaecistus Mill., England.
 Heath (*Erica* sp.), England and Sweden.
 Heather (*Calluna* sp.).
 Holly (*Ilex crenata* Thunb.).
 Honeysuckle (*Lonicera* sp.).
 Hop tree (*Ptelea trifoliata* Linn.).
 Horse-chestnut (*Aesculus hippocastanum* Linn.).
Hovenia inaequalis.
 June-berry (*Amelanchier* spp.).
 Leather leaf (*Chamaedaphne calyculata* Moench).
 Lilac (*Syringa persica* Linn.), (*S. vulgaris* Linn.).
 Lime (*Citrus* sp.).
 Linden. (See Basswood.)
 Locust, cultivated (*Robinia pseudacacia* Linn.).
 Locust, water (*Gleditsia aquatica* Marsh.).
 Maple, red (*Acer rubrum*).
 Maple, striped (*Acer pennsylvanicum* Linn.).
 Maple, sugar (*Acer saccharum* Marsh.).
 Maple, mountain (*Acer spicatum* Lam.).
Mespilus cuneata Miq.
 Moose-wood (*Dirca palustris* Linn.).
 Mountain ash (*Sorbus americana* Marsh.).

Mountain ash, European (<i>Sorbus aucuparia</i> Linn.).	<i>Rhamnus</i> sp.
Myrtle (<i>Myrtus</i> sp.).	Rose (<i>Rosa rugosa</i> Thunb.).
Nectarine (<i>Amygdalus persica nectarina</i> Ait.).	Sassafras (<i>Sassafras sassafras</i> Karst.).
New Jersey tea (<i>Ceanothus americanus</i> Linn.).	Silverberry (<i>Elaeagnus argentea</i> Pursh.).
Oak (<i>Quercus pedunculata</i> Ehrh.). (<i>Quercus</i> spp.).	<i>Spiraea</i> spp.
Orchid.	Spruce (<i>Abies firma</i> Sieb. & Zucc.).
<i>Pachysandra terminalis</i> Sieb. & Zucc.	Sunflower (<i>Helianthus</i> sp.).
Peach (<i>Amygdalus persica</i> L.).	Sycamore (<i>Platanus</i> sp.).
Pear (<i>Pyrus communis</i> Linn.).	Tallow tree (<i>Sapium sebiferum</i> Roxb.).
Pear, Seckel.	Tamarisk (<i>Tamarix africana</i> Poir.).
Peony (<i>Paeonia</i> sp.).	Tree of Heaven (<i>Ailanthus cacodendron</i> [Ehrh.] Schinz. & Thell.).
Peppergrass (<i>Lepidium suffruticosum</i> Linn., Cav.).	Tulip-tree (<i>Liriodendron tulipifera</i> Linn.).
<i>Planera keakei</i> C. Koch.	Umbrella tree (<i>Magnolia tripetala</i> Linn.).
Plum (<i>Prunus domestica</i> Linn.).	<i>Viburnum</i> sp.
Poplar, Carolina (<i>Populus deltoides</i>).	Virginia creeper (<i>Ampelopsis quinquefolia</i> Michx.).
Poplar, Lombardy (<i>Populus nigra</i> var. <i>italica</i> Du Roi).	Willow, goat (<i>Salix caprea</i> Linn.).
Poplar, white (<i>Populus alba</i> Linn.).	Willow, Napoleon (<i>Salix babylonica</i> Linn.).
<i>Prunus sargentii</i> .	Willow, osier (<i>Salix viminalis</i> Linn.).
Quince (<i>Cydonia vulgaris</i> Pers.).	Willow (<i>Salix aegyptiaca</i> Forsk.).
Raisin tree (<i>Hovenia dulcis</i>).	Willow (<i>Salix pedicellata</i> Desf.).
Raspberry (<i>Rubus</i> spp.).	Walnut, English (<i>Juglans regia</i> Linn.).
	Walnut (<i>Juglans</i> sp.).
	Yucca (<i>Yucca</i> sp.).

PARASITIC AND PREDACEOUS ENEMIES.

Minute parasitic wasps are often efficient enemies of this scale, and in some localities they apparently hold the insect in check. If these little friends¹ are present, small round holes can be seen on the dorsal part of the scale showing where the adult escaped.

The larvæ of coccinellids, or ladybeetles, are sometimes found feeding on these insects, and certain species of mites assist in their destruction. Birds are also credited with doing service, the most efficient being the titmice and tree creepers.

THE SCURFY SCALE.

The scurfy scale, while infesting a considerable number of plants, is a less general feeder than is the preceding species. It occurs principally upon rosaceous plants, such as the apple, peach, pear, plum, cherry, etc., and also on currant and gooseberry among cultivated plants, but seldom becomes so abundant as to cause particular injury or to require specific treatment. The insect may be recognized from the accompanying illustration (fig. 3), much enlarged. The scale of the female is dirty gray in color, irregularly pear-shaped, as shown in the picture. The male scales are much smaller, elongate, snowy white,

¹ Those more commonly found are *A phelinus mytilaspidis* Le B., *A. abnormis* How., *A. fuscipennis* How., *A. diaspidis* How., *Aspidiotiphagus citrinus* How., *Anaphes gracilis* How., and *Cheiloneurus diaspidinarum* How.

with three distinct keels extending longitudinally along the back. Unlike the former species, the scurfy scale is a native North American insect, and appears to be less adaptable to the various conditions throughout the country, and has thus a more restricted distribution.

LIFE HISTORY AND HABITS.

The scurfy scale, like the oyster-shell scale, winters in the egg condition under the scales. The number which may be deposited by a

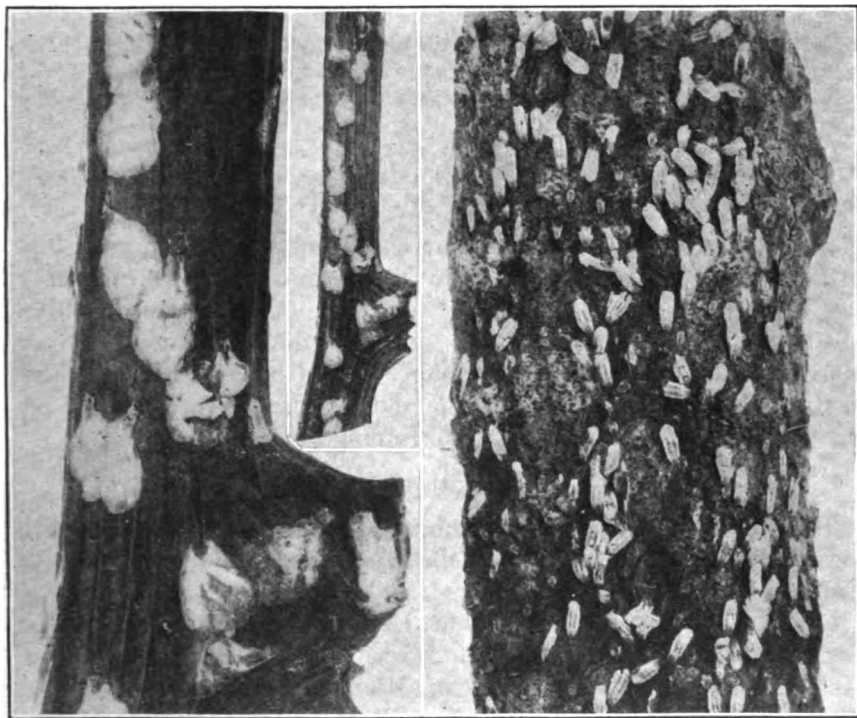


FIG. 3.—The scurfy scale (*Chionaspis furfur*). Male at right, female at left. All enlarged. (Authors' illustration.)

given female, as may be easily verified by examination, varies considerably. The following records show the number of eggs from each of twenty individuals:

Number of eggs deposited by the scurfy scale. (Material collected on apple sprouts from base of apple stump March 31, 1905, at Arlington Farm, Virginia.)

Scale No.	Eggs.	Scale No.	Eggs.	Scale No.	Eggs.	Scale No.	Eggs.
1	61	6	74	11	54	16	82
2	18	7	78	12	61	17	23
3	78	8	70	13	48	18	83
4	98	9	19	14	68	19	21
5	53	10	41	15	78	20	33

Average number of eggs per scale, 57.5.

The following records from literature and from the Bureau of Entomology will indicate the times of hatching of the eggs of this insect in the spring for several localities:

Ontario: Eggs hatch about June 1 (Jarvis).

Connecticut: Eggs hatch usually between May 20 and June 1 (Britton).

New York: Eggs hatch at about same time as those of oyster-shell scale.

Ohio: Eggs hatch, and young are crawling, during latter part of May or in early June (Houser).

Illinois: Eggs hatch from June 5 to 12 (Walsh).

Missouri: Eggs hatch soon after the formation of the young apples, the date depending upon locality and upon forwardness of the spring (Taylor).

District of Columbia: Eggs hatch from May 15 to June 1 (Howard).

Delaware: Eggs hatch about same time as those of oyster-shell scale, which is usually early in May (Houghton).

Tennessee: Eggs hatch in April, and there are two broods annually (Bentley).

Georgia: In 1906 eggs hatched March 11 to 22. Eggs for second brood hatched beginning about June 2.

In the more northern States there is but one brood each year, but in the South, as in Tennessee and in Georgia, there are evidently two full broods, and in the latter State there is a strong probability of a third. Thus, at Myrtle, Ga., in 1906, the eggs were hatching March 11, and hatching had probably ceased by March 22. Males of the new brood appeared May 15, and eggs had been deposited by the female May 28, the hatching beginning June 2.

DISTRIBUTION.

The following records of distribution have been compiled from various publications and from data collected by the Bureau of Entomology:

California, Colorado, Connecticut, Delaware, District of Columbia, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Utah, Virginia, Washington, West Virginia, and Wisconsin. In Canada it is recorded from New Brunswick, Nova Scotia, Ontario, and Prince Edward Island.

FOOD PLANTS.

The list which follows includes all plants upon which this species has been found, so far as it has been possible to determine from records in literature and from those in the Bureau of Entomology.

Apple (*Malus sylvestris* Miller).

Apple, Chinese flowering (*Malus spectabilis* Ait.).

Apple, crab (*Malus* sp.).

Ash, European mountain (*Sorbus aucuparia* Linn.).

Ash, mountain (*Sorbus americana* Ait.).

Ash, prickly (*Xanthoxylon americanum* Mill.).

Ash, white (*Fraxinus americana* Linn.).

Aspen, largetooth (*Populus grandidentata* Michx.).

Buckthorn (<i>Rhamnus cathartica</i> Linn.).	Maple (<i>Acer</i> sp.).
Cherry, choke (<i>Prunus virginiana</i> Linn.).	Peach (<i>Amygdalus persica</i> L.).
Cherry, wild black (<i>Prunus serotina</i> Ehrh.).	Pear (<i>Pyrus communis</i> Linn.). (<i>P. heterophylla</i> Dur.) (<i>P. melanocarpa</i>).
Cherry, wild red (<i>Prunus pennsylvanica</i> Linn.).	Plum, purple-leaved (<i>Prunus pissardii</i> Hort.).
Chokeberry, black (<i>Aronia melanocarpa</i> [Michx.] Elliott).	Plum, common garden (<i>Prunus domestica</i> Linn.).
Chokeberry, red (<i>Aronia arbutifolia</i> [L.] Pers.).	Quince (<i>Cydonia vulgaris</i> Pers.).
“Cherry currant.”	Quince, Japan (<i>Chaenomeles japonica</i> [Thunb.] Lindl.).
Cotton (<i>Gossypium</i> sp.).	Raspberry, black cap (<i>Rubus occidentalis</i> Pers.).
Currant, black (<i>Ribes nigrum</i>).	Red-twigged dogwood (doubtful record).
Currant, red flowered (<i>Ribes sanguineum</i> Pursh.). England.	Shad-bush (<i>Amelanchier canadensis</i> Me-dic.).
Elm (<i>Ulmus</i> sp.).	Sweet gum (<i>Liquidambar styraciflua</i>).
Gooseberry (<i>Ribes</i> sp.).	Sweet pepper bush (<i>Clethra alnifolia</i> Linn.).
Hawthorn (<i>Crataegus oxyacantha</i> Linn.).	Walnut, black (<i>Juglans nigra</i> Linn.).
Hickory, big bud (<i>Hicoria alba</i> Britt.).	Willow, white (<i>Salix alba</i> Linn.).
Horse chestnut (<i>Aesculus hippocastanum</i> Linn.).	

The scurfy scale is especially common on apple and pear, less usually so on cherry and peach; on which latter host in the South, in certain cases which have come under the writers' observations, it proved very destructive, greatly stunting the trees, although none had actually been killed.

PARASITIC AND PREDACEOUS ENEMIES.

This species is apparently not so subject to attack of parasitic and predaceous insects as the preceding, or else attention has not been directed to this phase of the insect's economy to an equal extent.¹

METHODS OF CONTROL FOR BOTH SPECIES.

Preparatory to spraying orchard, shade, and ornamental trees and plants for scale insects, they should be carefully gone over and any dead and weakened parts pruned out. The presence of such dead and dying wood is a distinct detriment, and its removal will greatly simplify the work of spraying.

TREATMENT OF ORCHARDS.

In orchards well sprayed during the dormant period for the San Jose scale each year, the oyster-shell and scurfy scales should rarely prove troublesome. While these insects, by reason of their wintering in the egg stage under the protecting female scales, are less susceptible to washes effective against the San Jose scale, yet the treatments will in most cases keep them reduced below injurious numbers.

¹ The following predaceous species are recorded as feeding upon the scurfy scale: *Tyroglyphus malus* (Shimer), *Chilocorus bifulvus* Muls., and *Hyperaspisidius* sp.

Among the parasitic Hymenoptera *Ablacus clivicampae* (Ashm.) has been reared from this species as well as *Phycus varicornis* Hlow., and a species of the genus *Prospaltella*.

In orchards where spraying for the San Jose scale is unnecessary and where the oyster-shell and scurfy scales are troublesome, specific treatments become desirable. There is considerable difference of opinion among entomologists as to the effectiveness of sprays applied during the dormant season to effect the destruction of the eggs. There is greater uniformity of opinion, however, as to the effectiveness of spraying shortly after the young have hatched and before there has been time for the formation of a thick protecting scale.

Recent observations and experiments, especially those by Messrs. E. W. Scott and W. S. Abbott in connection with the enforcement of the Insecticide Act of 1910, indicate that lime-sulphur wash is adequately effective against the oyster-shell scale applied during the dormant season, exactly as is done for the control of the San Jose scale. The lime-sulphur wash appears to seal the eggs and young under the scale covering, and probably also acts as a deterrent to the settling of the young lice on the twigs and branches. The effectiveness of such treatments, however, would probably vary with weather conditions which would tend to interfere with the "sealing" action of the wash. It is recommended, therefore, that orchardists use for the control of the oyster-shell and scurfy scales the lime-sulphur wash now in general use against the San Jose scale. A single dormant-tree treatment should be effective in controlling these three scale insect pests. It is essential, however, that very thorough applications be made, and in the case of large apple trees with a good deal of rough bark on the limbs and branches, this should be scraped off where practicable, since many of the scale insects will find protection under the loose pieces of bark.

If for any reason the dormant-tree treatment has not been satisfactory, as shown by the abundance of young scales hatching in the spring, an additional spraying, using kerosene emulsion or fish-oil soap wash, may be desirable, directed against the "lice" just hatched. The records of dates of hatching given under the remarks on life history for each species will indicate approximately when the young insects may be expected to appear, but this time may be accurately determined by frequent examinations of infested trees. The very small, yellowish insects will be seen in numbers crawling over the limbs and branches in their efforts to find a suitable place for settling. In general, the young of both species will have hatched and settled, and may be effectively treated during the period of from one to three weeks following the blooming period of the apple, and from two to four weeks after the blooming period of the peach. It will be preferable, however, to determine positively the time of crawling of the young for the particular locality and food plant by actual observations.

In spraying for the young insects when the trees are in foliage, the presence of the foliage will render thorough work more difficult, and special care will be necessary to reach all limbs and branches, treating every portion of the tree from top to bottom, as only those insects actually hit are destroyed. Dilute lime-sulphur wash, as used for fungicidal purposes, while of considerable value in destroying the newly hatched insects, is not as effective as kerosene emulsion or fish-oil soap wash, later mentioned under the head of formulas.

TREATMENT OF SHADE TREES.

The oyster-shell scale will often require treatment on maples, Lombardy and Carolina poplars, ash, and willow. Such trees should be sprayed with the strong lime-sulphur wash during the dormant period as advised for fruit trees, and if the insects have not been satisfactorily controlled, a supplemental treatment with kerosene emulsion or fish-oil soap wash should be made as the young are hatching. Effective spraying of shade trees, where these are of some size, will require painstaking work. In many cases it will be necessary for the man handling the nozzle to climb into the trees to reach the higher limbs and branches, and a long extension or bamboo rod is indispensable. The length of hose must be adapted to the height of the trees to be treated, and a coarse nozzle will be preferable, since it enables the operator to throw the spray some distance to inaccessible branches. A high pressure pump, from 150 to 200 pounds, is essential, though the writers have seen good work accomplished with an ordinary barrel outfit.

TREATMENT OF CURRANTS, GOOSEBERRIES, ORNAMENTAL SHRUBS, AND OTHER LOW-GROWING PLANTS.

After proper pruning, shrubs and bushes infested with these two scale pests should be thoroughly sprayed during the dormant period with the strong lime-sulphur wash as indicated for orchard and shade trees. If desirable, a supplemental treatment may be made as the young are hatching, as already indicated. A knapsack or bucket pump will be suitable for treating a few plants in yards, though if the amount of spraying to be done is considerable, a barrel pump would be preferable. Where infested yard plants are growing close to the wall of the building, this may be protected during the operation of spraying by a piece of tarpaulin, or other heavy cloth, or even waste paper.

SPRAY FORMULAS.

KEROSENE EMULSION (STOCK SOLUTION, 66 PER CENT OIL).

Kerosene emulsion is made after the following formula:

Kerosene (coal oil, lamp oil).....	gallons..	2
Fish oil or laundry soap (or 1 quart soft soap).....	pound..	$\frac{1}{2}$
Water	gallon..	1

First dissolve the soap in boiling water; then remove the vessel from the fire. Immediately add the kerosene, and thoroughly agitate the mixture until a creamy solution results. The stock emulsion may be more conveniently made by pouring the mixture into the tank of a spray pump, and pumping the liquid through the nozzle back into the tank for some minutes. The stock solution, if well made, will keep for some months, and is to be diluted before use. To make a 10 per cent spray (the strength for trees in foliage) add to each 1 gallon of the stock solution about $5\frac{1}{2}$ gallons of water. For 20 and 25 per cent emulsions (for use on dormant trees and plants) use respectively about $2\frac{1}{2}$ and $1\frac{1}{2}$ gallons of water for each 1 gallon of stock emulsion. Agitate the mixture in all cases, after adding the water. The preparation of the emulsion will be simplified by the use of a naphtha soap. No heat will be required, as the kerosene will combine readily with the naphtha soap, in water, when thoroughly agitated. Double the quantity of naphtha soap given in the above formula, however, will be required, and soft or rain water should be used in making the emulsion. In regions where the water is "hard" this should first be broken with a little caustic potash or soda, as common lye, before use for dilution, to prevent the soap from combining with the lime or magnesia present, thus liberating some of the kerosene, or rain water may be employed.

CRUDE PETROLEUM EMULSION.

Crude petroleum emulsion may be prepared in identically the same way as has just been described for kerosene emulsion, crude petroleum being substituted for kerosene. The grade of crude petroleum employed in the East is that known as "insecticide oil," having a specific gravity of 43° to 45° Baumé. The same dilutions for winter and summer spraying should be observed as stated for kerosene emulsion, but it should be noted that for summer treatments of trees in foliage the kerosene emulsion is preferable, as it is less likely to cause injury.

FISH-OIL SOAP WASH.

There are several brands of fish-oil soap on the market. Potash soap is preferable, and it should not contain over 30 per cent of water. For spraying dormant trees the soap is dissolved in hot water at the rate of 2 pounds to each 1 gallon, and spraying should be done before the wash cools, otherwise it is forced through the nozzle with difficulty. For spraying trees in foliage use the soap at the rate of 1 pound to 3 or 4 gallons of water, or even weaker.

LIME-SULPHUR WASH.

A good lime-sulphur wash may be made for immediate use by the following formula:

Stone lime.....	pounds..	20
Sulphur (flour or flowers).....	do....	15
Water to make.....	gallons..	50

Heat in a cooking barrel or vessel about one-third of the total quantity of water required. When the water is hot add all the lime and at once add all the sulphur, which previously should have been made into a thick paste with water. After the lime has slaked, about another third of the water should be added, preferably hot, and the cooking should be continued for one hour, when the final dilution may be made, using either hot or cold water, as is most convenient. The boiling due to the slaking of the lime thoroughly mixes the ingredients at the start, but subsequent stirring is necessary if the wash is cooked by direct heat in kettles. If cooked by steam, no stirring will be necessary. After the wash has been prepared it must be well strained as it is being run into the spray tank. It may be cooked in large kettles, or preferably by steam in barrels or tanks. This wash should be applied promptly after preparation, since, as made by this formula, there is crystallization of the sulphur and hardening of the sediment upon cooling. While an excess of lime, as in the above formula, adds nothing to the effectiveness of the wash, it serves by its color to indicate how thoroughly the trees are being coated. Another formula, with just sufficient lime for union with the sulphur, is employed by many orchardists in the preparation of the wash for immediate use as follows:

Stone lime.....	pounds..	7½
Sulphur (flowers or flour).....	do....	15
Water to make.....	gallons..	50

This is prepared as already indicated. While this wash may be stored without injury, it is better to prepare the "concentrate," as later described, if it is to be stored.

COMMERCIAL LIME-SULPHUR CONCENTRATES.

The inconvenience experienced in preparing the lime-sulphur wash according to the foregoing formula by cooking with steam or in open kettles at home has been one of the principal objections to this spray. Manufacturers have, therefore, put on the market concentrated solutions of lime-sulphur which have only to be diluted with water for use. These commercial washes, if used at proper strength, have proved to be quite as satisfactory in controlling the scale as the old-formula lime-sulphur wash, and, although somewhat more expensive, have been adopted by many of the commercial orchardists in prefer-

ence to making the wash at home. They are especially useful for the smaller orchardists whose interests do not warrant the construction of a cooking plant.

HOMEMADE LIME-SULPHUR CONCENTRATES.

The question of the preparation at home of concentrated lime-sulphur solutions which will not crystallize upon cooling, thus duplicating the commercial product, has been investigated by the Bureau of Entomology, as well as by numerous experiment station entomologists, notably by Profs. Stewart, Cordley, Parrott, and others. It has been demonstrated that it is practicable for orchardists to prepare concentrated stock solutions of lime-sulphur wash for immediate or later use, and many orchardists employ this plan. The necessary details for the preparation at home of lime-sulphur concentrates are given in Farmers' Bulletin 650 of this department. Those interested in the preparation for storage of lime-sulphur concentrate should write for this publication.

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UNITED STATES DEPARTMENT OF AGRICULTURE



FARMERS' BULLETIN



WASHINGTON, D. C.

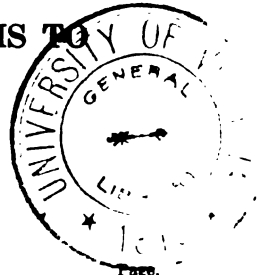
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JUNE 7, 1916

Contribution from the Bureau of Animal Industry, A. D. Melvin, Chief.

THE FEEDING OF GRAIN SORGHUMS TO LIVE STOCK.

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INTRODUCTION.

The most profitable disposal of the large crops of nonsaccharine, or grain, sorghums is a question which confronts many farmers in those sections of the United States where these grains are produced. A small proportion of the growers of these grains may, because of accessibility of markets, sell their grains at a direct profit; but the majority must find other avenues of marketing, and feeding them to live stock is practically the only alternative. Those who fully appreciate the feeding value of these crops will not hesitate to convert them into beef, pork, mutton, milk, or poultry. By marketing the crops in this way both the grain and the roughage are utilized; the manure is returned to enrich the soil; marketing is facilitated; and the farmer's chances for favorable financial outcome may be thereby greatly enhanced.

NOTE.—In those sections of the United States where nonsaccharine sorghums are produced the question as to the most profitable disposal of them confronts many farmers. Hence, the bulletin will be of interest to cattle feeders and farmers generally in the semiarid regions where grain sorghums do better than corn.

The nonsaccharine, or grain, sorghums which have been grown most widely in this country are kafir, milo, feterita, kaoliang, shallu, and durra. These crops are to the Great Plains Region what corn is to the Corn Belt. They may be fed green; both the cured plants and the seed or grain may be fed; or they may be ensiled. It has been demonstrated that the grain sorghums have less feeding value than corn, but the fact that they are heavy yielders in semiarid sections where corn fails more than compensates for the small difference in feeding value.

Closely related to the nonsaccharine sorghums are the saccharine, or sweet, sorghums. While the latter are not as satisfactory feeds as

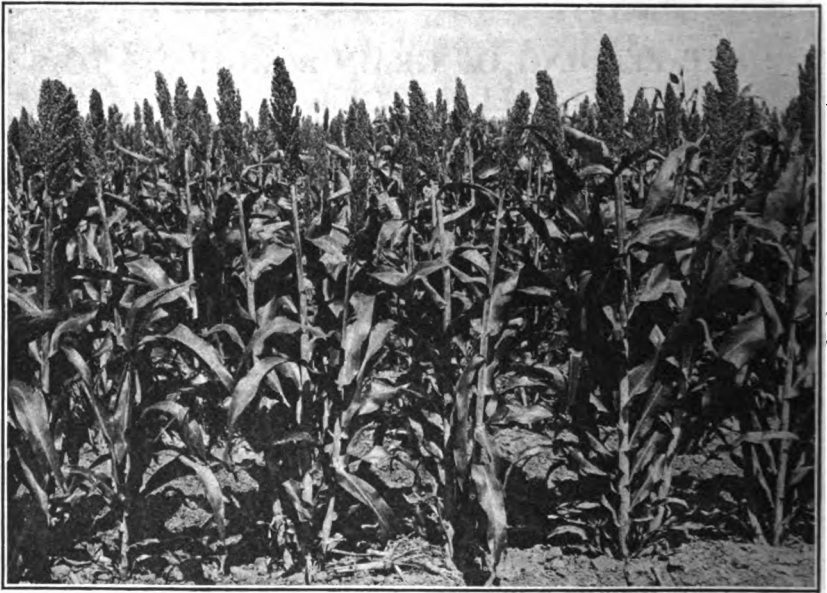


FIG. 1.—A plat of Dwarf Blackhull kafir. This variety matures earlier than standard Blackhull kafir. (From Farmers' Bulletin 552.)

the former, they are valuable in their place in certain sections of the country. The seed of sweet sorghums has been found to be much less palatable and nutritious than that of the nonsaccharine group. Consequently the greatest value of the sweet sorghums as stock feed lies in their use as forages. They produce a palatable hay or fodder much relished by stock and possessing about the same value as prairie hay.

In the South both classes of sorghums are pastured, particularly the sweet sorghums. The chief danger in the practice lies in the fact that poisoning may occur if stunted or second-growth plants are eaten. This point is more specifically referred to later on.

Some prejudice has existed as to the value of sweet sorghum for silage, based chiefly upon the charge that sorghum silage is highly acid. Experiments do not fully support this view, and stock have been given sorghum silage with splendid results. Owing to its deficiency of grain in comparison with corn, kafir, and milo silage it contains a smaller amount of nutrients per pound.

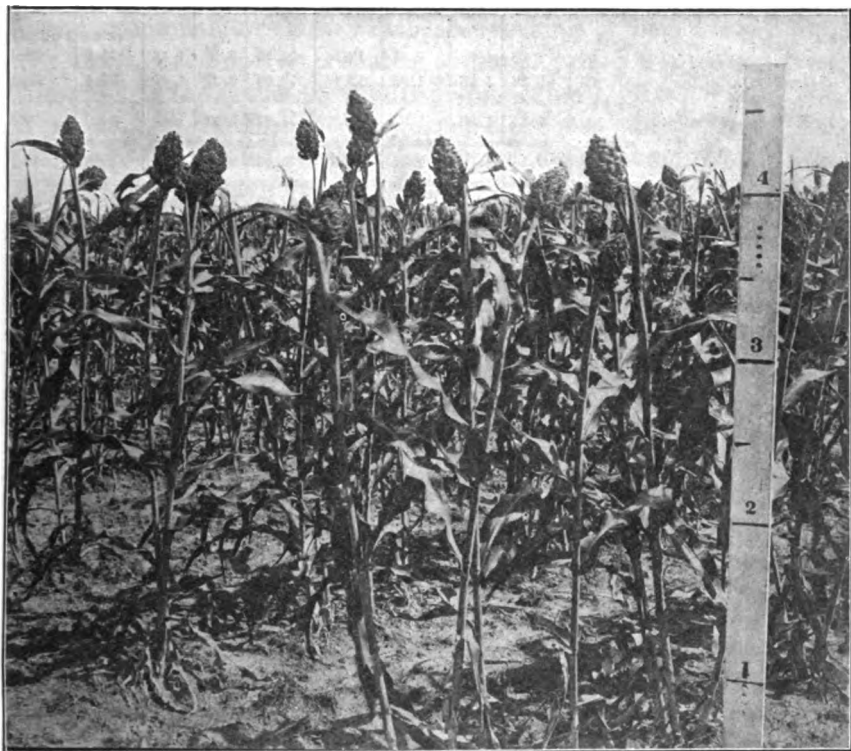


FIG. 2.—A plot of milo, selected for erect heads and low stature. (From Farmers' Bulletin 448.)

COMPOSITION AND DIGESTIBLE NUTRIENTS OF THE GRAIN SORGHUMS.

Chemical analyses of grain sorghums indicate that they are very similar to corn in composition. The fat content of the latter is higher, the protein percentage is greater in the sorghums, while the amounts of carbohydrates are practically equal in both. The following table taken from Farmers' Bulletin 686 shows the chemical analyses of several varieties of grain sorghums grown at the Amarillo station, Texas. The average of many analyses of corn is given for comparison.

TABLE 1.—Chemical analyses ¹ of air-dry samples of various grain-sorghum varieties grown at the Amarillo Cereal Field Station, Amarillo, Tex., 1908 to 1912, inclusive, compared with analyses of dent corn.

Feed.	Number of analyses.	Water.	Ash.	Nitrogen.	Protein.	Carbohydrates.	Fat.	Fiber.	Weight per—	
									1,000 kernels.	Busbel.
									<i>Grams.</i>	<i>Pounds.</i>
Milo.....	67	9.32	1.62	2.01	12.54	71.89	3.15	1.48	36.1	58.1
Dwarf milo.....	55	9.38	1.63	1.92	12.16	72.09	3.27	1.47	31.4	58.2
Average of 2 milos...	122	9.35	1.62	1.97	12.37	71.97	3.21	1.48	34.0	58.1
Feterita.....	8	9.58	1.72	2.24	14.00	70.32	2.90	1.48	32.2	55.9
Blackhull kafir.....	78	9.58	1.78	2.25	14.10	69.49	3.47	1.58	21.6	58.0
Dwarf blackhull kafir.....	13	9.95	1.70	2.09	13.09	70.49	3.25	1.52	16.6	58.7
Average of 2 kafirs..	91	9.63	1.77	2.23	13.95	66.65	3.43	1.57	20.9	58.1
Red kafir.....	37	9.56	1.73	1.92	12.01	72.03	3.16	1.51	18.5	58.3
Average of 3 kafirs..	128	9.61	1.76	2.14	13.39	70.33	3.35	1.55	20.1	58.2
Shallu ²	10	10.38	1.98	2.42	15.17	66.86	3.69	1.92	15.1	57.9
Average of all varieties....	268	9.52	1.70	2.07	13.01	70.95	3.29	1.53	26.6	58.1
Dent corn ³	86	10.60	1.50	.....	10.30	70.40	5.00	2.20	.....	.....

¹ The analyses were made by the Plant-Chemical Laboratory of the Bureau of Chemistry, U. S. Department of Agriculture.

² Grown only in the years 1911 and 1912.

³ Jenkins and Winton, Compilation of Analyses of American Feeding Stuffs. U. S. Dept. Agr., Office of Experiment Stations Bul. 11, 1892.

The amount of digestible nutrients which grain sorghums contain concerns the feeder more than does the composition. The digestible nutrients, it may be explained, are those compounds which are assimilated and used to produce heat, energy, fat, milk, muscle, and bone. The following table, from Henry and Morrison's "Feeds and Feeding," compares the digestible nutrients in 100 pounds, respectively, of kafir grain and shelled dent corn. Kafir may be taken as a representative of the groups of grain sorghums grown in the United States.

TABLE 2.—Digestible nutrients in 100 pounds of feed.

Feed.	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.			Nutritive ratio.
		Crude protein.	Carbohydrates.	Fat.	
Kafir grain.....	88.2	9.0	65.8	2.3	1:7.9
Dent corn.....	89.5	7.5	67.8	4.6	1:10.4

It is seen that kafir, in comparison with corn, is a little higher in digestible protein, but in carbohydrates and fats, which are the energy and fat producing compounds, it is somewhat lower.

VALUE AND USE OF THE GRAINS.

Horses, mules, cattle, sheep, hogs, and poultry have been fed the grains of these nonsaccharine sorghums with very satisfactory results. Breeding animals or those which are working or being fattened for the block eat properly prepared sorghum grains with much relish. However, as the grains are small and rather hard, grinding or crushing is recommended before feeding, except for sheep and poultry. Sheep masticate the small kernels well, thus rendering them readily accessible to the digestive juices, while poultry feed upon the unbroken grain, which is especially palatable to them in this form. If the grain is not ground for other stock it is less palatable and much of it passes through the digestive tract unbroken; thus much of the total feeding value is lost.

Very often the entire heads are ground up, producing a feed of greater bulk. The resulting meal, called head chop, resembles corn-and-cob meal in food value. It is recommended especially where the supply of roughage is limited, and usually is economical for feeding stock not being finished for market. Head chop is valuable in producing a high finish when supplemented by a rich concentrate such as cottonseed meal.

The quantities to be fed to the different kinds of animals depend upon many factors, such as the amount and kind of roughage and of other concentrates available, age, type, and size of the animals, and for what purpose the stock is being fed. Rations for various classes of stock are hereinafter suggested.

FEEDS RECOMMENDED FOR USE WITH SORGHUM GRAINS.

The feeder always should remember that sorghum grains alone do not form a balanced ration, and the same care which is exercised in feeding corn should be applied when feeding grains of the sorghums. This applies with particular emphasis to the rations for young and growing stock. Some feed which is rich in protein must also be given if favorable results are to follow heavy feeding of this class of grains. Where alfalfa, clover, or other leguminous hay can be had, no addition of protein-rich concentrates is necessary. Otherwise the ration should be balanced by adding some feed furnishing considerable protein. Cottonseed meal or cake and linseed meal have been most widely used for this purpose. Skim milk or tankage can be used to balance the pig's ration. Often other protein-rich feeds which supply the much-needed nitrogenous matter, such as soy-bean meal,

peanut meal, brewers' grains, etc., are available on the farm and may be profitably fed in connection with the sorghum grains. Maximum growth and development are attained in animals only where this attention to protein supply is given to the ration, and dairy cows fall far below their milking capacity when their rations are deficient in protein. A most liberal supply of the sorghum grains will not produce a first-class animal if it is not supplemented by some feed which carries a comparatively large amount of protein. Thus by an intelligent use of available feedstuffs the farmer can utilize the bulk of the roughage on his farm, feed the sorghum grains as the basis of properly balanced rations, and put beef, pork, mutton, and dairy products on the market which rank with the finest.

Since their introduction into this country the sorghum grains have been fed successfully to poultry. Most of the prepared poultry feeds which are offered on the market contain more or less of the grains of the sorghums. The grains do not require grinding, and are relished greatly by poultry, while they supply the energy and fat producing compounds in a desirable form.

VALUE OF THE SORGHUMS AS FORAGE.

The nonsaccharine sorghums may be utilized as forage in the form of stover and fodder or they may be put into silos. For these purposes the grain sorghums compare quite favorably with corn. Thus the grower may utilize the entire crop by feeding both the grain and the plant proper.

Well-cured stover and fodder from kafir, milo, etc., are well liked by live stock, and in some sections these constitute practically the sole roughage which the stock receive during the winter. Cattle can be well wintered at small expense on straw, fodder, or stover from the grain sorghums with a small allowance of some feed rich in protein. Linseed meal, bran, oats, or leguminous hay should be fed with the roughage to young stock, so that good growth will follow.

USE OF SILAGE ECONOMICAL.

As with corn, silage is perhaps the most economical form in which the grain sorghum crops may be utilized. Sorghum silage is very much liked by sheep and cattle, and its use in the rations of these classes of stock is very desirable. When cut at the proper stage it has a feeding value practically equal to that of corn silage. The grain sorghums should be cut for silage at the time the seeds are in the stiff dough stage. Silage is particularly useful in the ration of cattle to aid in keeping the body in proper tone and to increase the animal's appetite; thus by feeding silage the feeder and stockman are able to realize the maximum benefit from their crops of grain sorghums. The amount to be fed varies from a few pounds for a calf

up to 40 or 50 pounds or even more for a heavy producing dairy cow or a heavy steer. The amount of silage fed is affected by the kind of stock being fed and by the other components of the ration.

Silage is especially valuable when given liberally to stocker cattle. For animals that are producing heavily, silage should not be depended upon to supply the bulk of the nutrients which they require, as it is not a concentrate and contains a high percentage of water. A liberal addition of concentrates should be fed with it. By "producing animals" is meant dairy cows, working horses, and fattening animals, all of which are converting some of their feed into milk, work, or fat. In view of these advantages which silage feeding offers, growers of grain sorghums should endeavor to feed these crops in the form of silage as much as possible. A great number of experiments with cattle and sheep conducted under supervision of the

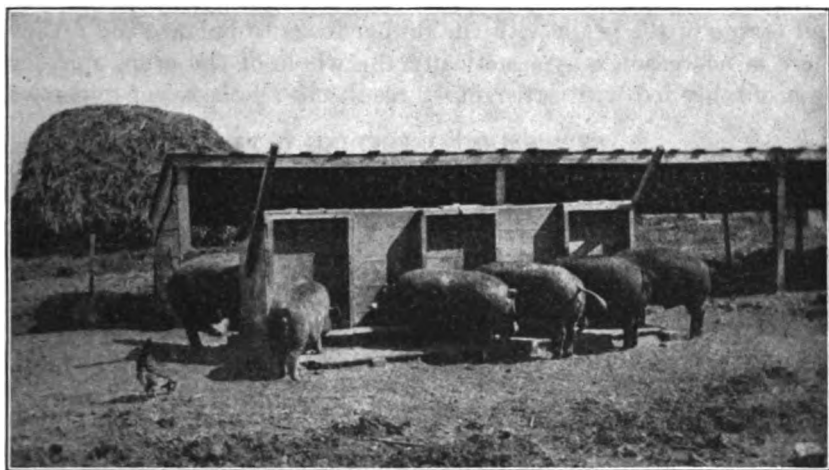


FIG. 3.—Fattening pigs on milo maize, using self-feeder.

Department and State stations fully substantiate this advice. Farmers' Bulletin 578 of the Department of Agriculture, which may be had upon request, gives detailed information concerning the handling and feeding of silage.

PRECAUTIONS TO BE TAKEN IN FEEDING GRAIN SORGHUMS.

Sometimes stock are killed by being pastured upon stunted or "second growth" plants of either sweet sorghums or nonsaccharine sorghums. Stunted plants may be caused by extreme drought or other adverse conditions. At such stages of growth prussic acid, a deadly poison, sometimes accumulates in the plant tissue, and consequently the stock may suffer severe poisoning, which is usually fatal. The plants have this poisonous property only under the conditions mentioned, and all losses may be avoided with a little care

on the part of the farmer. No losses have been reported from poisoning in feeding grain, heads, silage, hay, fodder, or stover of the nonsaccharine sorghums.

Some feeders have found that the sorghum grains, if fed heavily, produce a constipating effect upon stock. While this is not regarded as dangerous, it is well always to feed with them some material which is slightly laxative, such as linseed meal, bran, alfalfa, or soy beans. In this connection oat straw is also a valuable supplement.

Moldy grain-sorghum feeds in all forms should be avoided as much as possible, for more or less risk always attends the use of moldy feeds. Because of this the farmer should endeavor to harvest and store his crops with a view to minimizing this trouble. Farmers' Bulletin 686 furnishes information relative to the correct methods of harvesting and storing of sorghum crops.

If feeders will observe these precautions and supplement the grain and forage of the grain with the proper feeds to balance the rations, there is no reason why practically the whole of the crops may not be profitably fed with satisfactory results to all classes of live stock.

EXPERIMENTAL FEEDING DATA.

A number of practical cattle-feeding tests recently have been carried on in the Texas Panhandle region, under supervision of a field agent of the Bureau of Animal Industry. In these tests the grain sorghums were fed to beef cattle in a variety of forms and combinations and in most cases formed the bulk of the rations fed. The data gathered from this work indicate clearly the efficiency of the grain-sorghum feeds in the form of chop, head chop, silage, fodder, and stover, both in wintering cattle and in finishing them for the block. Silage of the grain sorghums, when fed as shown in Table 3, was found to be very beneficial for increasing the appetites of feeders, keeping them in fine condition, and adding a high finish. Cottonseed meal is very efficient as a supplement to kafir and milo feeds, and especially in conjunction with silage. Table 3 summarizes the results of this work.

TABLE 3.—*Results of use of grain sorghums in feeding tests carried out on Texas farms in cooperation with the U. S. Department of Agriculture, 1914-15.*

Age of cattle.	Number fed.	Date of feeding.	Length of feeding period.	Daily ration per head on full feed.	Total average gain per head.	Average daily gain per head.
			Days.		Pounds.	Pounds.
(1) 2 years.....	127	Oct. 28 to Feb. 2.....	97	Cottonseed meal; ¹ kafir chops; ¹ silage.	222	2.39
(2) 3 years.....	200	Jan. 1 to May 1.....	120	Sorghum fodder; ¹ cottonseed meal, 6 pounds; kafir chops, 8 pounds; silage, 40 pounds.	330	1.84
(3) 3 years.....	32	.....	165	Cottonseed meal, 4 pounds; mlo chops, 18 pounds; silage, 40 pounds; sorghum butts. ²	289	1.75
(4) 3 years.....	68	Jan. 17 to July 3.....	167	Cottonseed meal, 6 pounds; silage, 60 pounds; bundled kafir, 6 pounds.	292	1.75
(5) 20 months.....	90	Nov. 1 to Feb. 12....	102	Cottonseed meal, 4½ pounds; silage, 30 pounds; wheat straw. ²	213	2.08
(6) Steer calves.....	.....	Dec. 1 to Apr. 16....	136	Cottonseed meal, 3 pounds; kafir chops, 5 pounds; silage, 20 pounds; straw. ²	240	1.76
(7) Steer calves.....	63	Oct. 31 to June 4....	214	Cottonseed meal, 2½ pounds mlo chops, 10 pounds; silage, 20 pounds; wheat straw. ²	332	1.65
(8) Heifer calves....	116	Oct. 31 to May 1.....	180	Cottonseed meal, 2 pounds; mlo chops, 5 pounds; silage, 25 pounds; wheat straw. ²	249	1.38
(9) Heifer calves....	126	Winter.....	180	Cottonseed meal, 1½ pounds; mlo chops, 5 pounds; silage, 25 pounds; straw. ²	248	1.38
(10) Calves.....	.....	December - March, wintered only.	105	Cottonseed meal, ¹ silage, ¹ straw. ²	149	1.42

¹ Amounts not given.² Were given all they would eat.

On the whole the results in Table 3 indicate that the grain sorghums are efficient beef producers. The use of cottonseed meal and silage in all the rations is noticeable. These two feeds form an extremely palatable and efficient combination, and are conveniently fed together. The meal is usually mixed with the silage as it is fed. Dry roughages, such as straw, stover, and fodder, are readily eaten in connection with silage and cottonseed meal; thus the maximum amount of roughage may be utilized to advantage. Experiments Nos. 4, 5, and 10 in Table 3 illustrate these points well. If cottonseed meal is excessively high in price, it may be more economical to feed smaller

quantities than are indicated in these rations; but if no leguminous hay or other protein-rich concentrate is available it is advisable to feed some cottonseed meal to balance the ration. The increased growth and gain and the higher finish produced by its use justify the added cost of feeding it. The rations for beef cattle on page 12 are suggested with the high price of cottonseed meal in view. The amounts of grain sorghum in a ration should be increased when the allowance of cottonseed meal is cut down. One pound of cottonseed meal is usually considered equal in nutritive value to two pounds of sorghum-grain chop.

The State experiment stations at Manhattan, Kans., Stillwater, Okla., and College Station, Tex., have carried on feeding experiments

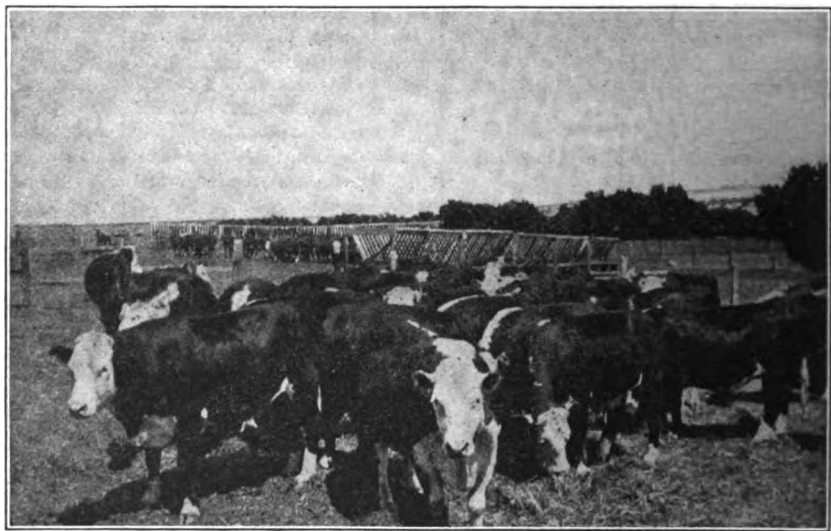


FIG. 4.—Two-year-old steers which topped the Kansas City market. Fed grain sorghum and cottonseed meal.

with various classes of live stock in which the grain sorghums formed a large part of the rations fed.

The Kansas station reports the economical use of kafir silage, wheat straw, and a small amount of cottonseed meal for wintering beef steers. Ground kafir and alfalfa hay were used very successfully for fattening steers. When no protein-rich concentrates or roughages were fed with ground kafir unsatisfactory gains followed. The Texas station has found that a mixture of about 4 parts of ground kafir or milo and one part cottonseed meal fed with cottonseed hulls and sorghum hay or kafir stover produced excellent gains. A larger amount of sorghum grain was fed than is customary in the case of corn. For example, a lot of 3-year-old steers were given a ration composed of 21 pounds ground kafir, 4 pounds cottonseed meal, and

all the kafir stover they would eat. These steers made an average daily gain of 3.1 pounds a head during a period of 85 days.

The Kansas and Oklahoma stations fed ground kafir with a large amount of alfalfa hay to dairy cows with good results at the pail and in condition of the cows. When the alfalfa hay was substituted by timothy, prairie hay, kafir fodder, or sorghum hay, milk production was seriously cut down, owing to the lack of protein in such combinations. Silage from grain sorghums in the rations of dairy cows proved practically as valuable as corn silage.

At the Kansas station pigs were fed ground kafir and milo supplemented by tankage and shorts, soy-bean meal, and alfalfa, with excellent results. In these experiments the largest and cheapest

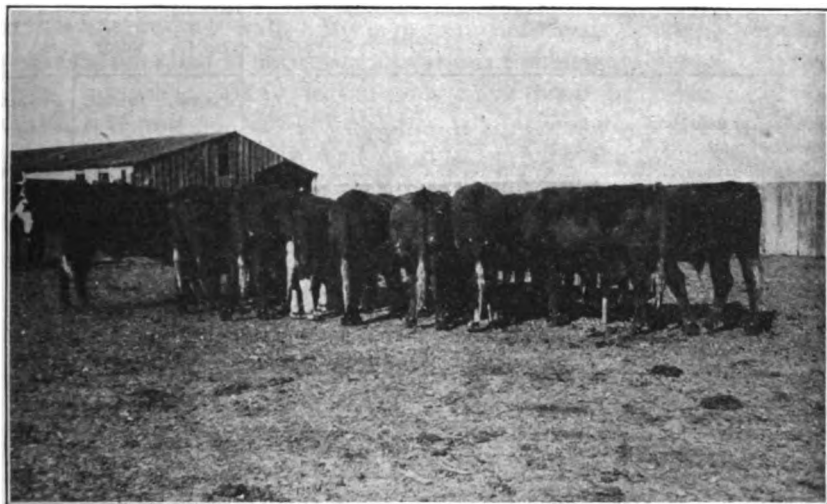


FIG. 5.—Steers in Texas Panhandle fed on milo-maize silage and cottonseed meal.

gains were produced by the ration in which shorts and tankage formed the supplements. Where sorghum grains have been properly supplemented by protein-rich feeds, they have produced only 2 to 10 per cent less gains than the same amount of corn would furnish.

Lambs were fed at the Kansas station, both whole and ground kafir being used with cottonseed meal. The gains secured indicate that the feeding value of these grains is slightly less than that of corn. Grinding the kafir for sheep and lambs did not pay.

Horses and mules have been fed the sorghum grains at the Oklahoma station, and the results indicate that for such stock these feeds are palatable and nutritious, and are also economical in regions where they grow better than corn. The experience of farmers who have long used these feeds for their horses and mules is in harmony with these reports.

SUGGESTED RATIONS FOR VARIOUS KINDS OF LIVE STOCK.

While no standard combination of feeds can be given which will apply economically to all sections where grain sorghums are grown extensively, the following rations are suggested for various classes of live stock. These are meant merely to serve as guides in formulating rations, and they may be varied to suit local conditions. The point in them which it is desired to emphasize is the profitable consumption of both grains and roughages in sections where the grain sorghums necessarily form the basis of the rations.

Daily rations for fattening steer weighing about 1,000 pounds.

Feed.	Ration.		
	No. 1.	No. 2.	No. 3.
	Pounds.	Pounds.	Pounds.
Kafir chop or milo chop	12	15	12
Cottonseed meal	2 to 3	.....	3
Kafir or milo silage	25	.....	40 to 45
Kafir and milo stover ¹ or straw	(¹)	(²)	(¹)
Alfalfa hay .....	.....	8	.....

¹ Give all they will eat.

² 5 pounds or more.

³ "Stover" means the cured plants after the heads have been removed.

Daily rations for wintering beef cattle 1,000 pounds in weight.

Feed.	Ration.		
	No. 1.	No. 2.	No. 3.
	Pounds.	Pounds.	Pounds.
Kafir or milo head chop	3	.....	3
Cottonseed meal .....	.....	1½	.....
Kafir or milo silage	25	40	.....
Alfalfa hay .....	.....	.....	8
Kafir or milo stover or straw	8 to 10	5	10 to 12

Sorghum hay may be used in place of some of the fodder or straw in these rations. Such roughage is usually fed in racks, so the cattle may eat all they want. In the fattening rations the proportion of roughage to concentrates should be much greater at the beginning of the feeding period than shown in the table above. Always put animals on full feed gradually. Toward the close of the fattening process the amounts of grain may often be increased to 17 pounds, or even more, and the proportion of roughage lowered accordingly. For smaller or larger animals decrease or increase the ration in proportion to size.

Daily rations for farm milk cow weighing about 900 pounds and producing 16 pounds of milk daily.

Feed.	Rations.	
	No. 1.	No. 2.
	Pounds.	Pounds.
Kafir chop or milo chop	3	8
Cottonseed meal	1	.....
Alfalfa hay	12	16
Sorghum hay, stover, or straw	5	5
Kafir or milo silage	30	.....

Cows which are giving milk must be fed generously if they are expected to produce well. More protein-rich feeds must be supplied in the ration than is necessary in rations for fattening stock or those being wintered. Many leguminous hays may be substituted for alfalfa. If no such hay is available, it is necessary to use a protein-rich concentrate. Cottonseed meal is perhaps the most reasonable feed of this class to purchase in the Southwest. Silage is also especially valuable as a dairy feed, and its use is strongly recommended.

Daily rations for a 1,200 to 1,400 pound horse doing moderate work.

Feed.	Rations.	
	No. 1.	No. 2.
	Pounds.	Pounds.
Kafir or milo chop	12	10
Alfalfa hay	10	.....
Kafir or milo stover or straw	6	6
Sorghum hay .....	.....	10
Cottonseed meal .....	.....	1

The amounts shown in these rations should be varied to agree with the size of the horse and the kind of work he is doing.

Daily rations for fattening hogs weighing 100 pounds.

Feed.	Rations.	
	No. 1.	No. 2.
	Pounds.	Pounds.
Kafir or milo chop	3 to 4	3 to 4
Soy-bean meal	$\frac{1}{2}$ to $\frac{1}{2}$	.....
Tankage .....	.....	$\frac{1}{2}$ to $\frac{1}{2}$

Ground alfalfa instead of soy-bean meal or tankage may be used with sorghum grains to furnish protein. Ration No. 2 would probably produce pork of better quality.

Daily rations for breeding sows per 100 pounds weight.

Feed.	Rations.	
	No. 1.	No. 2.
	<i>Pounds.</i>	<i>Pounds.</i>
Kafir or milo chop	1½ to 2½	3
Soy-bean meal or tankage	½ to ¾	.....
Ground alfalfa	½ to 1	1½

Skim milk or leguminous pasture may often profitably supply the protein required, in which case the tankage and soy-bean meal are eliminated. Protein and mineral matter should not be neglected in the rations of any breeding animal.

Daily rations for fattening sheep 100 pounds in weight.

Feed.	Rations.		
	No. 1.	No. 2.	No. 3.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Kafir or milo	1½	1½	1
Cottonseed meal	½	.....	½
Alfalfa hay .....	.....	2	.....
Sorghum hay	3	.....	1
Kafir or milo silage .....	.....	2	3

These rations should be varied according to the size of the lambs or sheep being fed and to conditions under which the feeding operations are being carried on. Near the close of the feeding period the amount of roughage shown above will usually need to be reduced.

It is to be remembered that the above are not given as perfectly balanced rations, and it will be advantageous in many cases for the feeder to substitute other available materials for some which are given. Furthermore, kafir and milo mentioned in the above rations may be replaced by the other nonsaccharine sorghums and practically the same returns realized. In suggesting these rations, however, attention has been given to the proportion of concentrates to roughages and to the amount of protein which the animals require.

Further information relative to the adaptability, cultivation, care, and use of the grain sorghums may be obtained by applying for publications in the list which follows.

**PUBLICATIONS OF THE U. S. DEPARTMENT OF AGRICULTURE RELATING
TO GRAIN SORGHUMS AND TO FEEDING OF LIVE STOCK.**

AVAILABLE FOR FREE DISTRIBUTION.

Feeding Farm Animals. (Farmers' Bulletin 22.)
Principles of Horse Feeding. (Farmers' Bulletin 170.)
Milo as a Dry-land Grain Crop. (Farmers' Bulletin 322.)
Forage Crops for Hogs in Kansas and Oklahoma. (Farmers' Bulletin 331.)
Computation of Rations for Farm Animals by the Use of Energy Values. (Farmers' Bulletin 346.)
Feeding Hogs in the South. (Farmers' Bulletin 411.)
Better Grain-sorghum Crops. (Farmers' Bulletin 448.)
Kafir as a Grain Crop. (Farmers' Bulletin 552.)
Use of Corn, Kafir, and Cowpeas in the Home. (Farmers' Bulletin 559.)
Making and Feeding of Silage. (Farmers' Bulletin 578.)
Beef Production in the South. (Farmers' Bulletin 580.)
Economical Cattle Feeding in the Corn Belt. (Farmers' Bulletin 588.)
Uses of Sorghum Grain. (Farmers' Bulletin 686.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS.

Nonsaccharine Sorghums. (Farmers' Bulletin 288.) Price, 5 cents.
The History and Distribution of Sorghums. (Bureau of Plant Industry Bulletin 175.) Price, 10 cents.
The Importance and Improvement of the Grain Sorghums. (Bureau of Plant Industry Bulletin 203.) Price, 10 cents.
Grain-sorghum Production in the San Antonio Region of Texas. (Bureau of Plant Industry Bulletin 237.) Price, 5 cents.
The Kaoliangs: A New Group of Grain Sorghums. (Bureau of Plant Industry Bulletin 253.) Price, 15 cents.
Cereal Experiments in the Texas Panhandle. (Bureau of Plant Industry Bulletin 283.) Price, 10 cents.
Feterita, a New Variety of Sorghum. (Bureau of Plant Industry Circular 122-C.) Price, 5 cents.
The Feeding Value of Cereals as Calculated from Chemical Analyses. (Bureau of Chemistry Bulletin 120.) Price, 10 cents.



FARMERS BULLETIN



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Contribution from the Bureau of Entomology, L. O. Howard, Chief.

WIREWORMS DESTRUCTIVE TO CEREAL AND FORAGE CROPS.

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INTRODUCTION.

The purpose of this bulletin is to enable farmers to distinguish between the different kinds of wireworms, so that they can make use of the method shown to be best in the control of each. It is apparent from several years of investigations into the habits and life histories of wireworms that many of the so-called wireworm remedies are of little or no value. Wireworms occur practically everywhere and attack a great variety of crops, and the character of the damage produced is similar in most cases and usually necessitates a reseeding or replanting.

The species here treated are the wheat wireworm¹ of the North-eastern and Middle Western States, the corn wireworms² of the Middle Atlantic and New England States and the Mississippi Valley, the meadow wireworms (including the sugar-beet wireworm³ and the confused wireworm⁴), the corn and cotton wireworm⁵ of the Southern States, and the dry-land wireworm⁶ and inflated wireworm⁷ of the dry-farming region of the Northwest and the wheat regions of the Northern Middle West.

¹ *Agriotes mancus* Say.

² *Melanotus communis* Gyll. and other species of *Melanotus*.

³ *Limonijs californicus* Mann.

⁴ *Limonijs confusus* LeC.

⁵ *Hloristonotus uhleri* Horn.

⁶ *Corymbites noxius* Hyslop.

⁷ *Corymbites inflatus* Say.

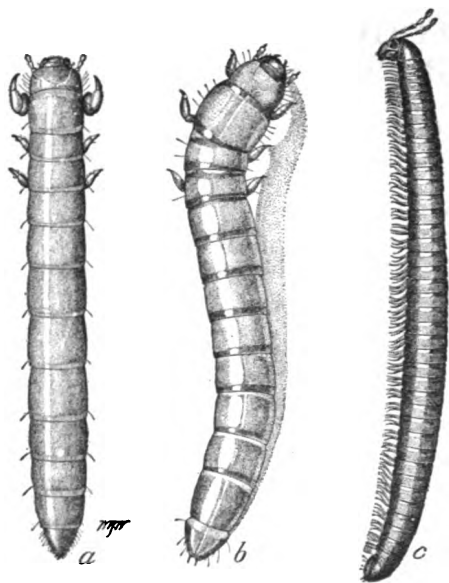
KINDS OF WIREWORMS, AND WHERE FOUND.

Wireworms are the young or worm stage of several kinds of hard-shelled beetles popularly known as "click-beetles," "skipping jacks," "snapping beetles," etc. These names are all derived from the beetles' unique habit of snapping the forepart of the body when placed on their backs or held between the fingers. This habit is undoubtedly of use to the beetles in righting themselves when accidentally overturned and may also be a means of escape from their natural enemies. Wireworms are elongate, more or less cylindrical, and have a very highly polished skin. They measure,

according to kind, from one-half inch to 3 inches in length. They have three pairs of short legs near the head end of the body. The color usually is yellow or reddish brown. The cotton and corn wireworm (fig. 4) is very different in appearance from all other wireworms.

The name wireworm is erroneously applied to the false wireworms of the Western States (fig. 1, *a*), and the mealworms found in granaries (fig. 1, *b*). In many parts of the country root webworms also are wrongly called wireworms, and the name is incorrectly applied to several kinds of "thousand leggers" (fig. 1, *c*).

FIG. 1.—Larvæ likely to be mistaken for wireworms; *a*, False wireworm; *b*, mealworm; *c*, "thousand legger." All enlarged. (Author's illustrations.)



True wireworms are among the five worst pests to Indian corn and among the 12 worst pests to wheat and oats. They are also important enemies to many other crops, notably potatoes and sugar beets. They constitute a group which is probably one of the two most difficult groups of insects to control. In the last part of this bulletin the results of recent investigations as to control measures are set forth.

These insects are destructive to cereal and forage crops in the larval or worm stage only, although the beetles of some kinds do considerable damage to the blossoms of fruit trees. Wireworms attacking cereal and forage crops confine their attention to the seeds, roots, and underground stems and live almost exclusively underground. The damage is first noticed immediately after seeding, when they attack the seed, eating out the inside and leaving only the hulls.

This, of course, results in a poor stand. In such cases, by digging into the hill, the wireworms may be located. When they are very numerous they often consume an entire seeding, and, aside from the extra labor and the cost of reseeding, this delays injuriously the planting of the crop. If this be corn in the Northern States, the part of the season remaining is too short to bring it to maturity, and, except for the fodder, the crop is a failure. Where wireworms are present, even in small numbers, corn usually makes a poor stand, so that the replanting of missing hills is necessitated.

Several hundred kinds of beetles, the young of which are wireworms, occur in North America. Many of these, however, are of little immediate importance to the farmers, as they live in rotten logs, under moss, or on the roots of weeds, or prey upon other insects. The destructive wireworms are found in nearly all parts of the United States. Some of these, such as the wheat wireworm and the corn wireworm, abound in heavy moist soils rich in vegetable matter. Some, as the inflated wireworm and the dry-land wireworm, prefer well-drained soils, and still others, like the corn and cotton wireworm, are most destructive on high sandy land which is very poor in vegetable matter. As the several kinds of wireworms have such varying habits they can not all be controlled in the same way, and a variation in method is required for each of the several groups. For this reason it is quite necessary to be able to determine what kind of wireworm is doing the damage.

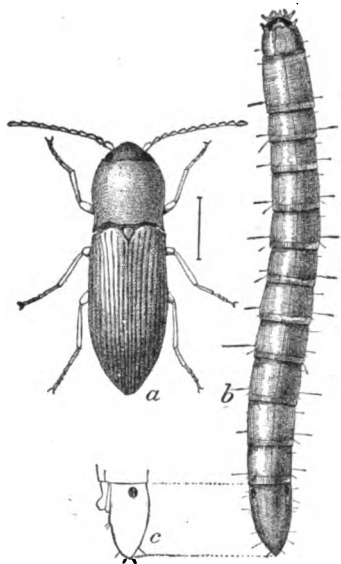


FIG. 2.—The wheat wireworm: *a*, Adult beetle; *b*, larva; *c*, side view of last segment of larva. All enlarged. (From Chittenden.)

THE WHEAT WIREWORM.

The adult, or beetle, of the wheat wireworm is brown and a little over one-fourth inch in length (fig. 2, *a*). The wireworm itself (fig. 2, *b*) is pale yellow, evenly cylindrical, and very shiny. When full grown it measures about 1 inch in length and is about as thick as the lead in a pencil. This wireworm can be easily recognized by the two dark spots near the base of the tail (fig. 2, *c*), and it is one of the commonest wireworms in the northeastern and middle-western United States. It is normally a grass feeder, living on the roots in

sod, and when its natural food supply is abundant it produces no appreciable disturbance in the meadows. When the sod land is broken, however, these wireworms gather in the drill rows or hills of corn, which is the usual crop to follow sod in the eastern United States, and often cause an absolute failure of the crop by destroying the seed and eating off the roots of such plants as may sprout. They also sometimes bore into the underground part of the stem of the plant. This wireworm is, therefore, usually more destructive on land recently broken from sod. However, in many cases the damage is more severe the second year following plowing from sod than the first. This is probably due to the fact that the wireworms feed upon the recently turned-down sod the first year, but are forced to attack the cultivated crop the second year, because by that time the sod has entirely decomposed. The wireworms spend three years in the soil before changing to beetles.

LIFE HISTORY.

The beetles come out of the ground in the early spring, during April and May. They then fly about and deposit their eggs in grasslands, the female beetles burrowing into the ground or under rubbish to deposit their eggs. The young wireworms feed during the ensuing summer and pass their first winter about half grown. The following spring they resume feeding and feed throughout the second summer, passing their second winter as full-grown wireworms. The third spring they again resume feeding, which they continue until early in July. They then leave the plants and form small earthen cells in the ground, and in these they transform to beetles. During the remainder of that summer and the third winter the beetles stay in the cells in which they transformed; then, during the fourth spring of their life they come out of the ground to lay their eggs.

CROPS ATTACKED.

The wheat wireworm feeds upon the seeds and roots of corn, potato tubers, wheat roots, carrots, turnips, and the underground stems of string beans, cucumbers, and cabbage, more or less seriously damaging or destroying the same.

REMEDIAL MEASURES.

When the land is intended for corn the following year, in order to counteract the ravages of the wheat wireworm, sod land should be plowed immediately after the first hay cutting, usually early in July. This land should be cultivated deeply throughout the remainder of the summer. Land that is in corn and badly infested should be deeply cultivated, even at the risk of slightly root-pruning the corn.

This should be continued as long as the corn can be cultivated, and as soon as the crop is removed the field should be very thoroughly tilled before sowing to wheat. In regions where wheat is seeded down for hay, any treatment of infested wheat fields is precluded. Where wheat is not followed by seeding to other crops, the field should be plowed as soon as the wheat is harvested; this kills the worms by destroying their food supply and preventing proper hibernation.

A thorough preparation of the corn land and a liberal use of barnyard manure or other fertilizer will often give a fair stand of corn in spite of the wireworms, a vigorous stand often being able to produce roots enough to withstand the depredations of several wireworms. Though not always practicable, the interposing of crops not severely attacked by wireworms, such as field peas and buckwheat, between sod and corn would materially reduce the number of wireworms in the soil at the time the crop is planted.

THE CORN WIREWORMS.

The beetles of the corn wireworms (fig. 3, *a*) measure from one-half to three-fourths inch in length, and they vary in color from light reddish brown to almost black. The wireworms (fig. 3, *b*) are reddish brown, about $1\frac{1}{4}$ inches long, cylindrical in shape, and always have three slight lobes or projections on the tail. These wireworms are pests to cereal and forage crops in the Middle Atlantic States, the New England States, and the Mississippi Valley.

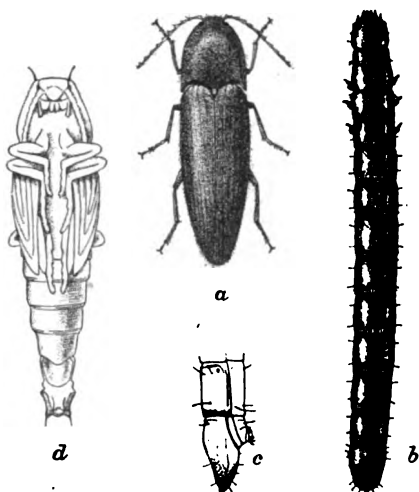


FIG. 3.—One of the corn wireworms: *a*, Adult; *b*, larva; *c*, last segments of same; *d*, pupa. All enlarged. (From Chittenden.)

LIFE HISTORY.

The beetles of these wireworms emerge in the spring and deposit their eggs in grasslands. The corn wireworms, however, spend a considerably longer time in the soil than the wheat wireworms. In some cases the corn wireworms live in the ground as long as six years. They change to beetles during August, and some beetles spend the following winter in the cell in which they transform. The beetles of some kinds of corn wireworms apparently spend the winter under the bark of decaying trees.

REMEDIAL MEASURES.

The corn wireworms are almost exclusively confined to poorly drained and heavy soils. Heavily liming and thoroughly tile-draining land infested with these wireworms would undoubtedly prove beneficial. The thorough cultivation of waste land, especially along drainage ditches and creeks, during midsummer, and the deep cultivation of crops and fallow land at the same time would destroy large numbers of them.

THE MEADOW WIREWORMS.

The meadow wireworms, including the sugar-beet wireworm and the confused wireworm, do far more damage than they are generally given credit for. In the Pacific Northwest they damage corn and potatoes and other truck crops. They have also been found doing considerable damage in the New England States and the upper Mississippi Valley. In the Northwest they seem to be much more destructive on irrigated lands than on the dry-farming lands, while in the eastern United States they seem to be confined to poorly drained areas, as are the corn wireworms. Meadow wireworms look very much like the dry-land wireworm and can be easily distinguished from the other wireworms which are important as crop pests by the forked tail. The meadow wireworms attack corn, potatoes, tomatoes, onions, cabbage, radishes, turnips, horse-radish, spinach, sugar beets, and alfalfa. They burrow into the underground parts of the plants, often killing corn, tomatoes, cabbage, or onions. They do not seem to attack beans or peas, and these crops might be of considerable value in clearing badly infested fields prior to seeding to corn. The meadow wireworms spend three years in the ground and change to beetles during July and August of their third summer.

REMEDIAL MEASURES.

Thorough tile draining of infested fields in the eastern areas and deep cultivation during July and August wherever possible will destroy large numbers of these wireworms. As most of this poorly drained land is inclined to be acid, the tilth will be greatly improved by the addition of lime at the rate of about 2 tons to the acre, using air-slaked lime. The use of lime, however, has been treated very fully in both Government and State publications, and it would be advisable for the farmer to apply to the State or Federal authorities for the rate and kind of lime to use in his particular case.

On irrigated land experiments are being made to determine remedial measures.

THE CORN AND COTTON WIREWORM.

The beetle of the corn and cotton wireworm (fig. 4, *a*) is small, cylindrical, and dusky brown, measuring a trifle over three-sixteenths inch in length. The "worm" (fig. 4, *b*) is very unlike any of the other wireworms. It is not hard and wiry, but soft and elongate. The body usually is white and apparently is composed of 26 joints.

When full grown this wireworm is about as thick as a heavy pack-thread. Unlike most of the eastern wireworms, which are usually most destructive on low-lying, heavy, or poorly drained lands, this wireworm seems to be far more numerous on the higher parts of the field in light sandy soils. The corn and cotton wireworm is one of the most troublesome pests of the southern United States. Bad outbreaks have occurred in the Carolinas, Missouri, Arkansas, and southern Illinois. Corn, oats, rye, cowpeas, crab grass, Johnson grass, peanuts, cotton, tobacco, sweet potatoes, and watermelons are all attacked, corn suffering the most of all. Investigations are now under way to determine efficient remedial measures for this insect.

THE DRY-LAND WIREWORM AND THE INFLATED WIREWORM.

The dry-land wireworm (fig. 5) and the inflated wireworm, which are very similar in appearance, seem to be confined to the dry-farming regions of the Northwest and to the wheat regions of the northern Middle West. Early in May the beetles emerge from the ground. They are about in large numbers during May and in June, when the females burrow into the ground to deposit their eggs. These wireworms do not confine their egg laying to grasslands, but deposit the eggs in grain fields and weedy fallow lands. The wireworms spend two full summers and a part of a third in the ground, transforming to beetles during July and August of the third summer, the beetles not coming from the ground until the fourth spring. Thus the wireworms, as such, are in the ground during the growing season of three years. The beetles of the inflated wireworm have been observed in large numbers on the blossoms of wild rosebushes, where they were apparently eating the petals. The beetles of the dry-land wireworm are a little later in coming out of the ground, emerging in June and July. In the dry-land regions this wireworm feeds only during the spring, burrowing down from 4 to 8 inches below the surface to pass the hot, dry months.

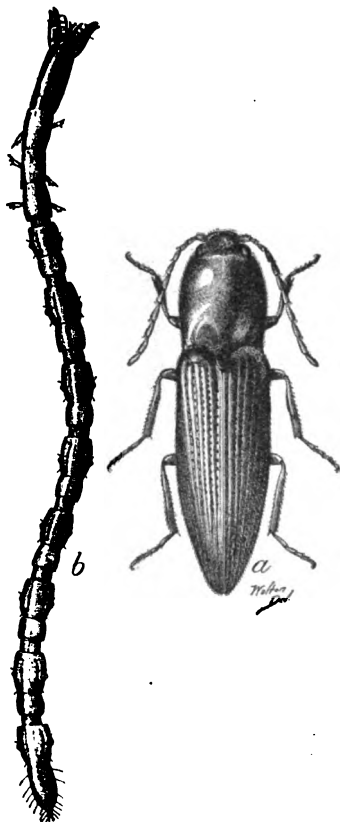


FIG. 4.—The corn and cotton wireworm: a, Adult beetle; b, larva. Enlarged. (Author's illustration.)

REMEDIAL MEASURES.

As will be seen from the life history, the generations about to become adults are inactive wireworms from June to August, transforming to beetles in the early part of August. The resting and transforming wireworms usually are found at a depth of 4 to 8 inches, and any disturbance of the soil to such depth at this time will destroy them. The ground is very hot during this period of the year, and the air extremely dry, so that even the resting wireworms that are not actually crushed by the cultivation soon succumb to drying when their cells are broken open. The usual farm practice in the

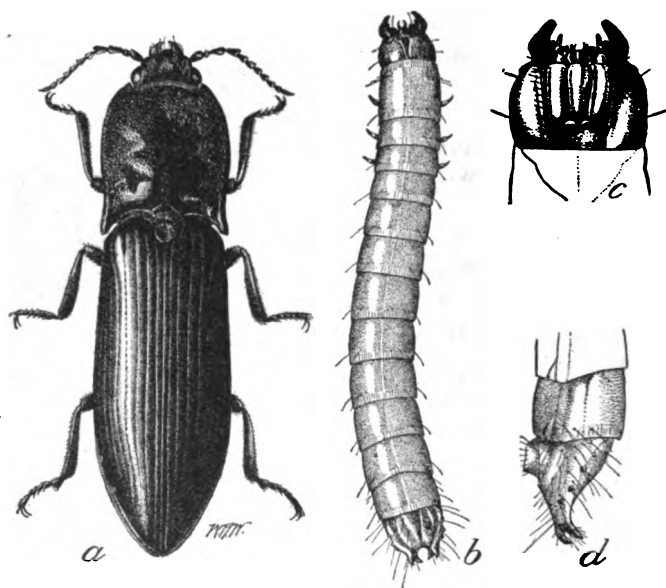


FIG. 5.—The dry-land wireworm: *a*, Adult; *b*, larva; *c*, under surface of head of larva; *d*, side of last segment of larva. *a*, *b*, Enlarged; *c*, *d*, more enlarged. (Author's illustration.)

dry-land farming region of the Northwest where these wireworms are most troublesome may be roughly outlined as follows:

Immediately after seeding the wheat in early spring the summer fallow land is plowed to a depth of from 4 to 7 inches. This usually is done in April, but if horses and help can be spared from seeding, the summer fallow is plowed as early in the spring as the land can be worked. The next operation on the fallow land is disking the land in June or early July to maintain the dust mulch and kill the weeds and volunteer wheat. Some of the more progressive farmers now practice fall plowing of the stubble and disking the fallow land only in the spring. The field is disk-harrowed early in the spring if the land has run together during the winter and is caked, otherwise the land is harrowed with a drag or spring-tooth harrow. It is then

seeded and dragged and receives no further treatment until harvest. The seeder usually is set to sow at a depth of about 3 inches, although, if the moisture content is high enough, 1 inch is considered sufficient. Wheat hay is used extensively in this country, and is cut while the wheat is in the dough stage, which usually is from July 4 to July 15. The wheat crop is harvested from August 1 to September 15. In order to destroy wireworms this practice should be altered in the following manner:

(1) Disk or drag-harrow the summer fallow as early as possible in the spring in order to produce a dust mulch and thereby conserve the accumulated winter moisture. (2) Continue the disking as often as is necessary in order to maintain the dust mulch and keep down the

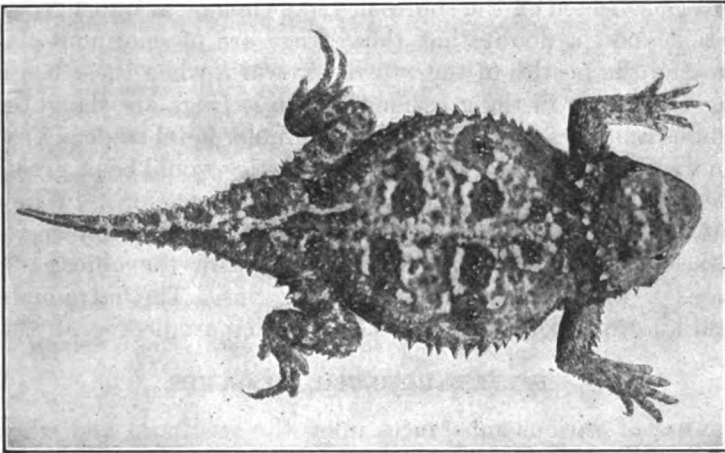


FIG. 6.—A horned toad, an enemy of the western wireworms. (Author's illustration.)

weeds. (3) Plow the summer fallow in July or early in August and immediately drag. (4) Plow the stubble as soon as the crop is removed.

As these wireworms are of three different ages in most infested fields, and as only about one-third of these are in the pupal stage, changing to beetles each year, it is evident that the first year of this practice will not show marked results. However, if the practice is continued for two years it will reduce the number of these pests very considerably. Aside from its beneficial results in killing insects, this method of handling the land will materially reduce the weeds, the early disking merely softening up the soil and allowing all the weed seeds present to sprout, the entire crop of weeds subsequently being destroyed by the summer plowing. By the present method of farming, the weed seeds are turned down to such a depth that many can not germinate; but they lie dormant, and sprout whenever they happen

to be brought to the surface by subsequent cultivation. One crop of weed seed is in this manner often a pest for several succeeding years.

NATURAL ENEMIES OF WIREWORMS.

Most of our common song birds feed rather extensively upon both the beetles and the wireworms themselves, and any regulation designed to protect these birds and encourage their increase will undoubtedly be effective in reducing the number of these pests. In the desert regions of the West the small lizards, commonly called sand toads or horned toads (fig. 6), feed very extensively upon wireworms and their beetles and should be protected by the farmers of these regions. The examination of the stomachs of a large series of field frogs collected on the shores of Lake Oneida, in upper New York, proves beyond a doubt that these frogs are of enormous value in destroying the beetles of the wheat wireworm when these beetles are laying their eggs in the grasslands. These frogs are slaughtered in enormous numbers every year for the summer hotel trade. Any regulation which would put a stop to this practice would be of great value to the agricultural interests of this and similar sections. Wireworms are not severely attacked by parasites, so far as is known. However, several parasites are being studied with the object of using them as a means of controlling wireworms. The introduction of several known fungous diseases also is being studied.

USELESS REMEDIAL MEASURES.

The use of various substances upon the seed corn and wheat has proven of little value in fighting wireworms. The application of certain commercial fertilizers recommended as insecticides is also of but little use. The application of lime is not effective as an insecticide, but is of value in rendering the soil more easily drained. Late fall plowing has probably been the most universally recommended method of combating these insects. However, at least for the kinds of wireworms on which this method has been tried, it is quite useless. Trapping the larvæ with baits of poisoned vegetables may be of some value under intensive methods of farming, but it is impracticable in the growing of field crops.

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- Cotton Bollworm, Some Observations and Results of Field Experiments in 1904. (Farmers' Bulletin 212.) Price, 5 cents.

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